~~JOB SHEETS~~

JOB SHEETS

Los Angeles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

AS-

ELECTRONICS TECHNICIAN

ASSIGNMENT SHEET

DC Theory

Materials: TM11-661

Introduction: To understand the nature of electricity this study covers the basic theory of the structure of matter. With this knowledge it is possible to determine what makes a electrical charge and the nature of charged bodies, Also that the flow of electricity actually is the movement of electrons from one level of potential energy to another,
Included is an introduction to the units of measurement, and Ohm's Law.

Assignment: Study Chapter 2 to 5 of TM-661

Test:

1. Define the following:
    a. element
    b. atom
    c. compound
    d. electron
    e. proton and neutron

2. What effect does distance have when varied on the force of charges?

3. What is meant by the word potential?

4. Define conductors and insulators.

5. What is resistance and its unit of measurement?

6. State Ohm8s Law and give three equations for I, E, and R.

7. Describe the effect a rise in temperature has on a copper conductor.

8. What is the definition of an ampere?

9. Describe the difference between a voltmeter and an ammeter and their use in an electrical circuit.

10. Give the color code of a 500,000 ohm resistor.

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Instructor: R.H. Oeffinger

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Lucas - A.

ELECTRONICS TECHNICIAN

ASSIGNMENT SHEET

DC Circuits

Materials: TM-661 and Principles of Radio--Henney

Introduction: DC circuits provide the nescessary foundation to understand complex electronic circuits. A good knowledge of these circuits will always be important for electronic eqùipment consists in a a great part a DC voltage distribution system, in which the greater majority of troubles occur.

Assignment: Study chapters 6 and 9 in TM-661 and chapter 2 in Henney.

Test: Turn in work for the following problems:

TM-661
a to j on page 63
1 to 8 on pages 108 to 111

Henney
problems 46 to 48 in chapter 2

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JS-

LUCAS. A.

ELECTRONICS TECHNICIAN

JOB SHEET

Multimeter

Objective: How to manipulate and read indications on a multimeter.

Materials: Various sizes of resistors and power supply.

Equipment: Multimeter.

Procedure: Draw the scales of your instrument and show where the following readings are located, giving the settings of the function and range switches:

Ohms: 100, 2K, 50K, and 1 Meg.

Volts DC: 5, 120, and 600.

Volts AC: 250, 400, and 800.

Measure and record the resistance of the resistors

120 OHMS, 2000 OHMS

52 K OHMS - 2 MEG. OHMS

Measure and record all AC and DC voltages found in the power supply.

190 V. D.C+ 350 V D.C+ 295 V D.C+

4 V. A.C. 6 V A.C.

Summary Questions:

1. What precautions must be observed when measuring voltages after a resistance measurement?

   MAKE SURE THE FUNCTIONAL SWITCH IS CHANGED FROM THE OHMS POSITION TO VOLTS POSITION

2. How many times greater will the 100X setting be than the 10X?

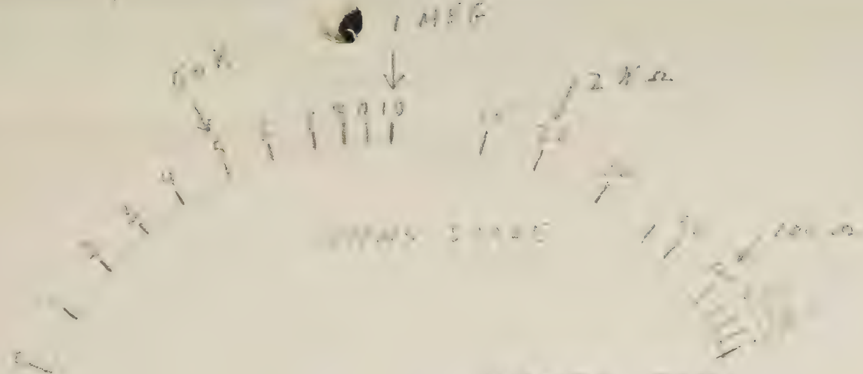
   10 TIMES GREATER

3. What part of the ohmmeter scale is the most accurate?

   CENTER 2/3 OF THE SCALE

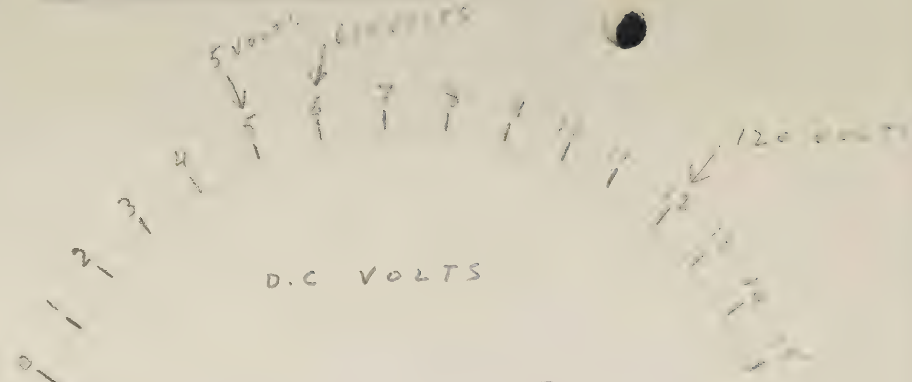
4. What pecaution must be made when measuring an unkown voltage?

   SET THE RANGE SWITCH IN THE HIGHEST POSITION.



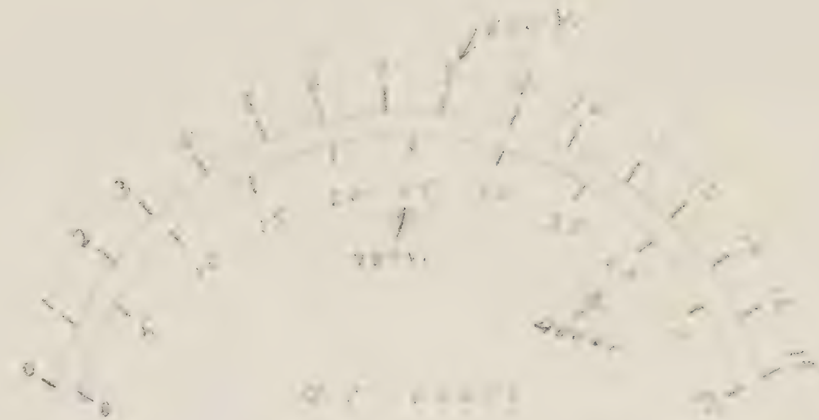
FUNCTION SWITCH ON: OHMS

RANGE FOR:
100Ω ON RX1
2 KΩ " RX100
50 KΩ " R X 10 K.
1 MEG " R X [illegible]



FUNCTION SWITCH ON DC+

RANGE FOR:
5V ON 15 VOLTS
120V ON 150 VOLTS
600 V ON 1500 VOLTS



FUNCTION SWITCH ON A.C VOLTS

RANGE FOR:
250 V. ON 500 VOLTS
400 V ON 500 VOLTS
800 V ON 1500 VOLTS

Schools: Los Angeles Trade Tech. J.C.	Title: MULTIMETER SCALES	Date
Los Angeles, California	Drawn By: [illegible]	[illegible]
Class: Electronics	Approved By:	

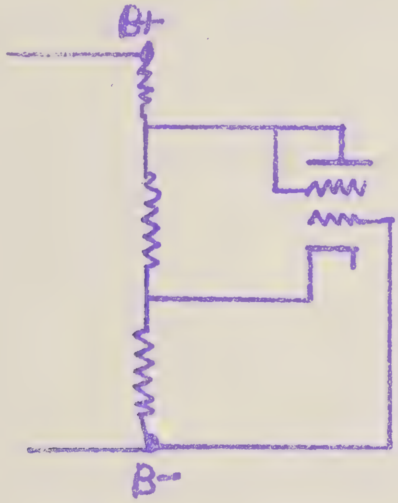
ELECTRONICS TECHNICIAN

JOB SHEET

Voltage Divider--Loaded

Objective: How to construct a voltage divider for a given load and to study the effects of load on EMF.

Materials: Obtain vacuum tube from instructor.



Equipment: Multimeter, power supply and tube manual.

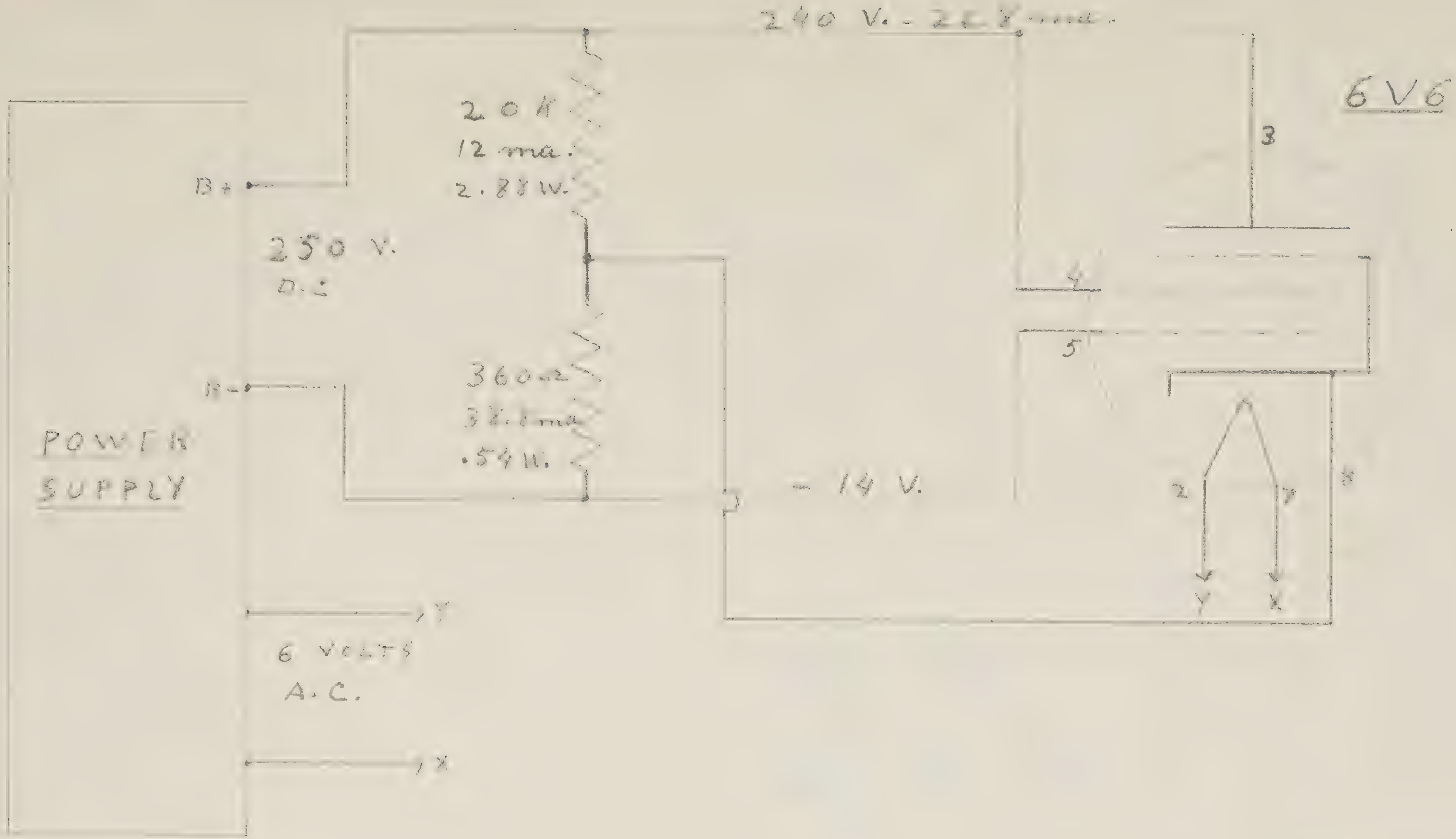
Procedure: From data in tube manual determine current and voltage requirements for tube.
Measure no load voltage of power supply.
Load power supply with a load equivalent to the tube and measure voltage again. The voltage should still be higher than needed if the power supply is the proper type. Increase the load 10 ma. more than load requirements. Measure voltage again. This voltage and current will be the basis for designing the bleeder.

Construct circuit similiar to one shown above.

Draw schematic of your circuit and included values of all resistances and voltages found on tube and across bleeder.

Question: What is the value of the bleeder current?

12 ma.



School: Los Angeles Trade Tech J.C.	Title: VOLTAGE DIVIDER	Date:
Los Angeles, California	Drawn By: LUCAS, AGUSTIN	SEPT. 21-56
Class: Electronics	Approved By:	

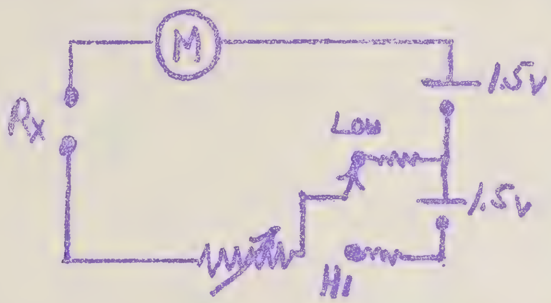
ELECTRONICS TECHNICIAN

JOB SHEET

Series Type Ohmmeter

Objective: How to construct and understand the characteristics of the common ohmmeter.

Materials: Basic meter, two $1\frac{1}{2}$ volt batteries, decade box (resistance) and components to construct circuit as shown.



Procedure: Construct ohmmeter with two ranges. Use $1\frac{1}{2}$ volt for one range and 3 volts for the higher range. Use decade box to check accuracy of meter and two calibrate.

Draw calibrated scales:

School: Los Angeles Trade Tech J.C. Los Angeles, California	Title: SERIES TYPE OHMMETER	Date
Class: Electronics	Drawn By: LUCAS AGUSTIN	SEPT. 27 1950
	Approved By:	

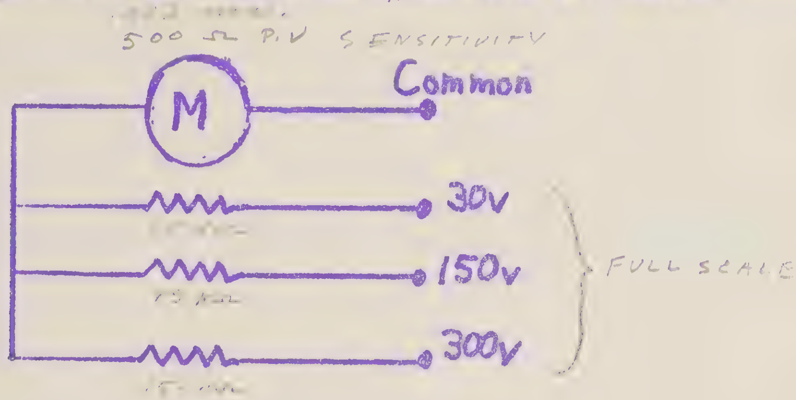
ELECTRONICS TECHNICIAN

JOB SHEET

Voltmeter

Objective: How to construct, understand limitations, and use of the voltmeter.

Materials: Meter used on job sheet for Meter Sensitivity, and components to construct circuit as shown:



Equipment: VTVM and power supply.

Procedure: Construct a voltmeter having three ranges up to 300 volts.

Measure the voltages obtained from the bleeder resistor of the power supply with the VTVM and the voltmeter you have just constructed. Record each separately:

Bleeder Tap	VTVM	Voltmeter
1. 30 V.	30 V.	27.5 V
2. [illegible]	[illegible]	[illegible]
3. [illegible]	[illegible]	[illegible]
4. [illegible]	[illegible]	[illegible]
5. [illegible]	[illegible]	[illegible]

Job Sheet

Voltmeter (cont.)

Summary Questions:

1. Why did the voltages measure higher with the VTVM?

THE HIGH RESISTANCE OF THE VTVM DOES NOT LOAD THE CIRCUIT AS THE [illegible]

2. Describe the importance of meter sensitivity when measurâng voltages in electronics circutts.

THE SENSITIVITY OF A METER'S IS OF HIGH IMPORTANCE. IF A METER OF LOW SENSITIVITY IS CONNETED TO A CRITICAL CIRCUIT, IT WILL DRAW TOO MUCH CURRENT THERE,FOR GIVE UN-ACCURATE READINGS. THE HIGHER THE RESISTANCE OF THE METER, THE HIGHER THE SENSITIVITY.

Los Angeles Trade Tech. Jr. College
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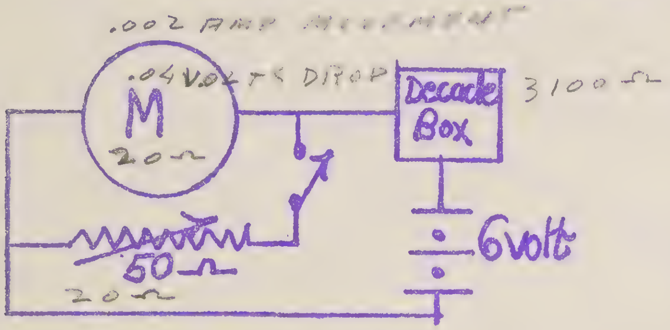
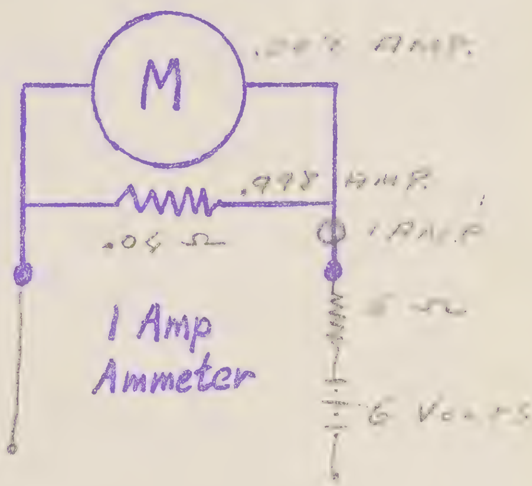
JOB SHEET
Ammeter and Meter Resistance

Objective: How to measure meter resistance and construct an ammeter.

Materials: Basic Meter, 6 volt battery, and components to construct circuits as shown:



Measuring Meter Resistance



1 Amp Ammeter

Equipment: Resistance decade box, and resistance bridge.

Procedure: To measure resistance of meter, adjust dedade box with switch open for variable shunt until meter reads full scalw. Close switch and adjust shunt until meter reads ½ scale. Measure shunt resistance and record. This the practicl value of the meter resistance.

To construct the ammeter, use data obtained above. If your meter has a low value of resistance, use resistance wire for the shunts. The proper length can be measured with the bridge, and wound on 3/8 or ½ inch tubing.

Summary: Write a technical report on how the procedure used in this job measures the resistance of the meter.

Los Angeles Trade Tech. Jr. College
Instructor: H.H. Oeffinger

ELECTRONICS TECHNICIAN

JOB SHEET

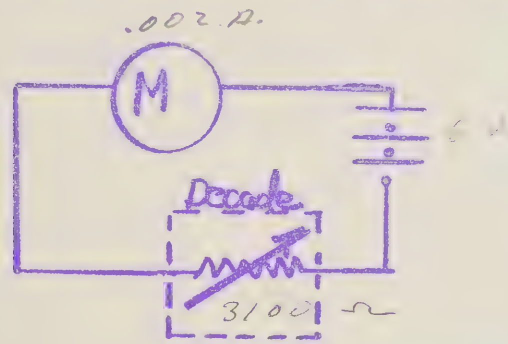
Voltmeter Sensitivity

Objective: How to measure meter sensitivity.

Materials: Milliammeter(DC), Resistance Decade Box, 6 volt battery, and hookup wire.

Procedure: Connect circuit as shown:

CAUTION!!! Check to see that full range of resistance in decade box is in circuit before connecting battery.



Adjust resistance until meter reads full scale. Record value of resistance.

3100 Ω

Summary Questions:

From the above data calculate the following:

1. Current flow for full scale deflection.

.002 AMPS $\left(\frac{6}{3100} = .002\right)$

SERIES RESISTANCE - 3100 Ω

VOLTAGE DROP ACROSS METER. .04 VOLTS.

METER INTERNAL RESISTANCE - 20 Ω

2. Ohms per volt.

#1 $\frac{20\Omega \text{ INTERNAL RESISTANCE}}{.04 \text{ METER VOLTAGE DROP}}$ = 500 OHMS PER VOLT

#2

ELECTRONICS TECHNICIAN

JOB SHEET

R-C Time Constant

Objective: How to construct a R-C time circuit and to understand time with respect to the charge and discharge of R-C constants.

Materials; To perform and construct circuits as illustrated:

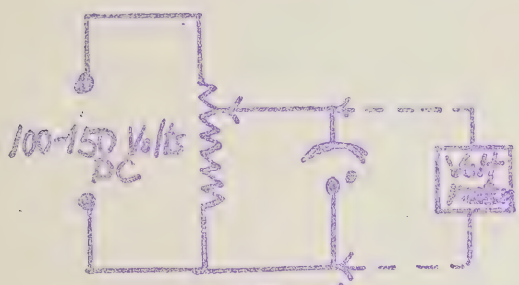


Fig. 1

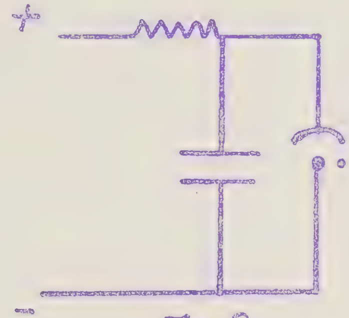


Fig. 2

Equipment: VTVM and low voltage power supply.

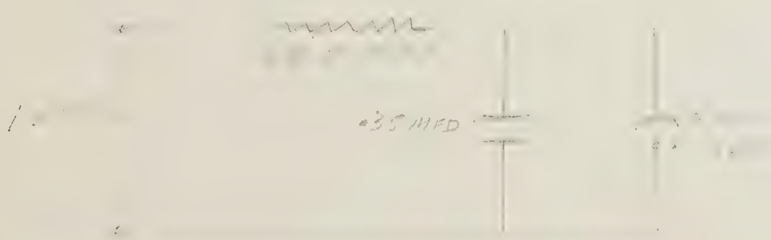
Procedure: With equipment set up as shown in fig. 1, find the firing and deionizing points of the lamp. Record these voltages 85 V 68 V 110.

Calculate and construct circuit to make neon lamp flash once every second. Draw schematic giving all values:

85 : 110 = 77 % ; 68 : 110 = 64 % = 1 T.C 5.5 SEC

TC - 10 SEC. 10 = RC. C = .35

R = $\frac{10}{.35}$ = 28.5 MEG.



Summary Questions:

1. If resistance is in the megohms and capacitance is in microfarads. What unit of time will the constant be in?

Seconds

2. If resistance is in ohms and capacitance in microfarads, what unit of time will the constant be in?

microseconds

3. What percentage of full charge is two time constants?

86%

4. What percentage of discharge is three time constants?

5%

Los Angeles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

ELECTRONICS TECHNICIAN

ASSIGNMENT SHEET

R-C Time Constants

Materials: Keith Henney, and Glen Richardson, Principles of Radio, Chapter 6, sections 6.3, 6.4, 6.5, and 6.6.

Army Tech. Manual, TM 11-681, Electrical Fundamentals (Alternating Current), Chapter 3, Section 43

Navships 900,016, T.O. 16-1-195, Radar Electronic Fundamentals, Section III, paragraph 17.

Introduction:

A knoweledge of R-C time constants to a electronics technician is important, since all electronic circuits in one form or another contain a combination of resistance and capacitance. A resistor and capacitor provides an accurate and inexpensive method for timing and wave shaping.

Assignment:

Read references given under material.

Test:

1. If a 1k ohm resistor and a .05ufd capacitor are connected in series, what is the time constant of the circuit?
2. A capacitor has 300 volts across it when fully charged. If it is connected in a circuit with a resistor in series, what will the voltage be at the end of three time constants if the circuit is shorted? 15 V
3. How many time constants will it take a capacitor-resistor combination to reach 95% of the applied voltage? 3

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Instructor: R.H. Oeffinger

ELECTRONICS TECHNICIAN

JOB SHEET

R-C Time Constant

Objective: How to construct a R-C time circuit and to understand time with respect to the charge and discharge of R-C constants.

Materials: To perform and construct circuits as illustrated:

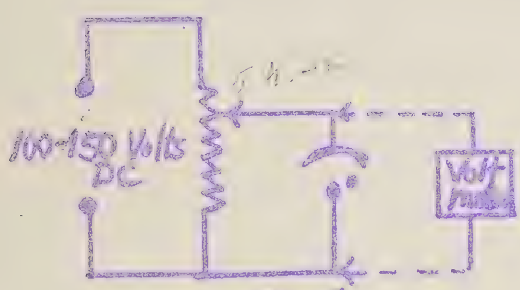


Fig. 1

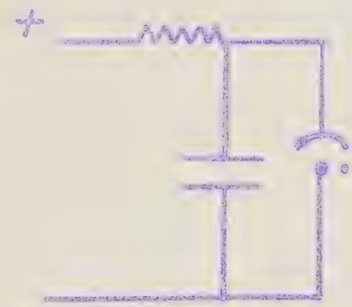


Fig. 2

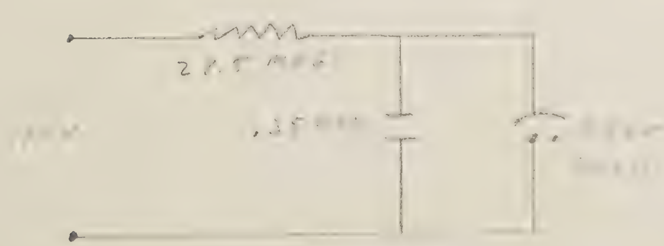
Equipment: VTVM and low voltage power supply.

Procedure: With equipment set up as shown in fig. 1, find the firing and deionizing points of the lamp. Record these voltages FIRE AT 85 V. . . 110 SUPPLY

Calculate and construct circuit to make neon lamp flash once every 5 seconds. Draw schematic giving all values:

$85 \div 110 = 77\%$; $.5 \div 110 = 64\%$; $5 = \frac{1}{2}$ T.C.

$10 = R.C$ $R = \frac{10}{35} = 28.5$ MEG.



Summary Questions:

1. If resistance is in the megohms and capacitance is in microfarads. What unit of time will the constant be in?

SECONDS

2. If resistance is in ohms and capacitance in microfarads, what unit of time will the constant be in?

MICRO SECONDS

3. What percentage of full charge is two time constants?

80%

4. What percentage of discharge is three time constants?

95%

ELECTRONICS TECHNICIAN

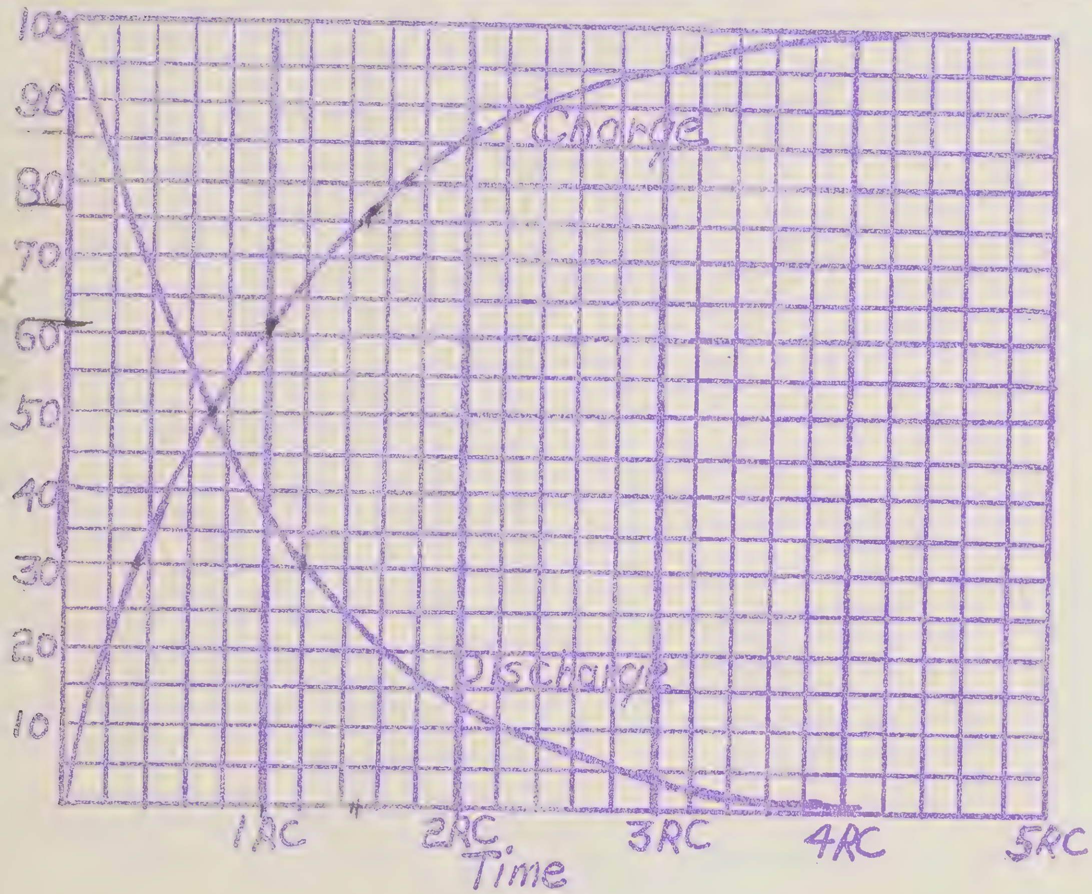
INFORMATION SHEET

RC Time Constants

R-C Time Constant: The time required to charge a capacitor to 63% or to discharge it to 37% of its final voltage.

The value of the time constant in seconds is equal to the product of the circuit resistance in ohms and capacity in farads.

110 UNIVERSAL CHARGE AND DISCHARGE CURVES OF R-C CIRCUITS



SHORT TABLE OF UNIVERSAL TIME-CONSTANT VALUES

Time in Seconds	% of Applied-Charge	% of Applied-Discharg
.5RC	39	61
1 RC	63	37
2 RC	86	14
3 RC	95	5
4 RC	98	2
5 RC	99	1

ELECTRONICS TECHNICIAN

JOB SHEET

Oscilloscope Fundamentals

Objective: How to manipulate an oscilloscope.

Equipment: Oscilloscope, audio oscillator, and scope calibrator.

Procedure: Draw a diagram of the front panel of the oscilloscope and label all controls and their use:

CONTROLS AND THEIR USE:

[illegible]TICAL AND HORIZONTAL POSITION: VARY TH[illegible] DEFLECTION PLATES TO MOVE T[illegible] AND RIGHT.

[illegible]SITY CONTROL: VARIES THE VOLTAGE [illegible] GRID OF THE [illegible] RAY TUBE

[illegible] AMP.: SYNCRONIZES THE [illegible] TOOTH WAVE WITH THE IN[illegible]

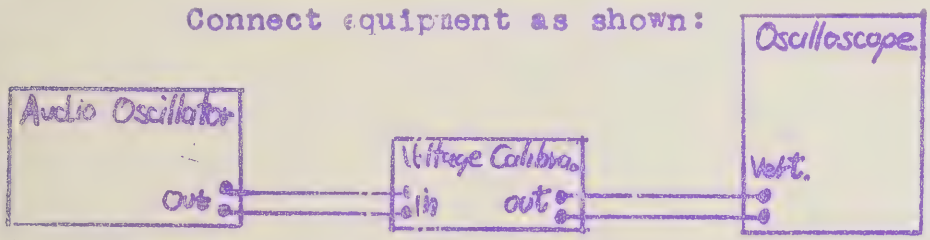
[illegible]: VARIES VOLTAGE BETWEEN [illegible] FINE FREQ, [illegible]

[illegible] BE SEEN ON THE TIME BASE [illegible].

[illegible] AND HORIZ. AMPL.: USED [illegible] TO AMPLIFY [illegible] BETTER ON THE FACE OF THE SCOPE.

[illegible] GRAM DRAWN ON SEPARATE [illegible]

Connect equipment as shown:



Observe waveforms at 30, 60, 400, and 1500 cycles.
Use voltage calibrator and set the output of the oscill[illegible] at 2 volts peak to peak.

Summary Questions:

1. What is the horizontal sweep rate of the scope in [illegible] case if three full cycles are observed at the different frequencies under procedure?

2. Describe peak to peak, effective, rms, average, and maximum values.

IVE VALUE: =

R.MS -

XIMUM IS THE VALUE

3. Describe your method for using a source of filament voltage to calibrate an oscilloscope.

4. Give your procedure for using the voltage calibrator in this job sheet.

FIRST SET CALIBRATOR FO

TO B

AIN ON

SET CALIBRATOR TO SIGNA

A SIGNA

VOLTAGE A

ON SCOPE

School: Los Angeles Trade Tech J.C.	Title: OSCILLOSCOPE PANEL	Date
Los Angeles, California	Drawn By: LUCAS AGUSTIN	
Class: Electronics	Approved By:	

JOB SHEET

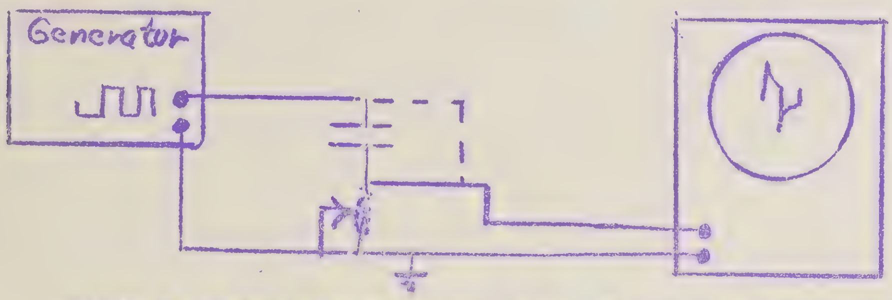
Integrating and [illegible] Circuits

Objective: How to observe the effects of RC circuits.

Materials: Potentiometer and capacitor used for RC circuit.

Equipment: Square wave audio generator and oscilloscope.

Procedure: Connect equipment and materials as shown:



With a fixed frequency show in each case the shape of the wave form across the capacitor and the resistor for time constants of 1/10 and 10 times one alternation of the input frequency.

(Use form)

Summary Questions:

1. What must the sum of voltages across the resistor and capacitor be equal to? THE INPUT VOLTAGE.

2. Explain how the peak voltage across the resistor can be twice the input voltage?

AT THE [illegible]

[illegible]

[illegible]

VOLTAGE. THIS [illegible]

ACROSS THE R[illegible]

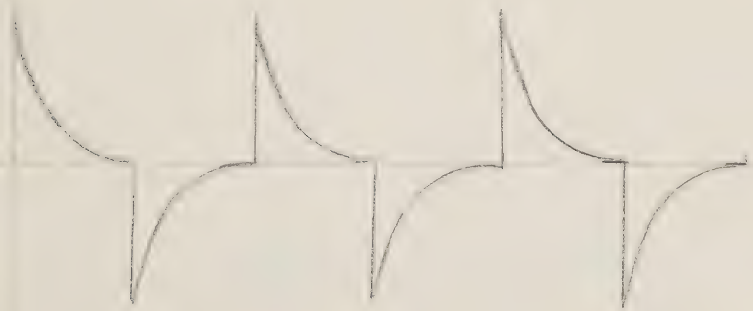
WAVE FORMS DRAWN ON SEPARATE SHEET [illegible]

[illegible] .1 [illegible]

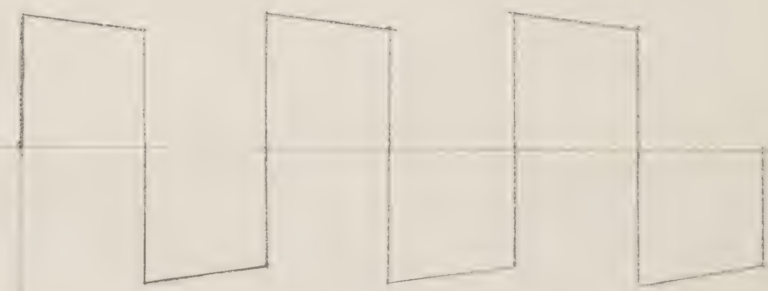
1/10 OF ONE ALTERNATION OF THE INPUT WAVE. AND .1 [illegible]

AND 50KΩ FOR THE T.C. OF 10 TIMES ON[illegible]

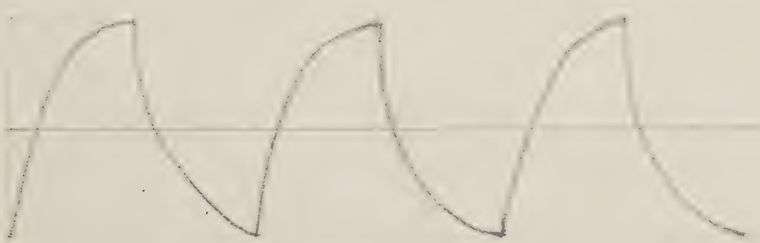
AT AN INPUT FREQUENCY OF 1000 CYCLES



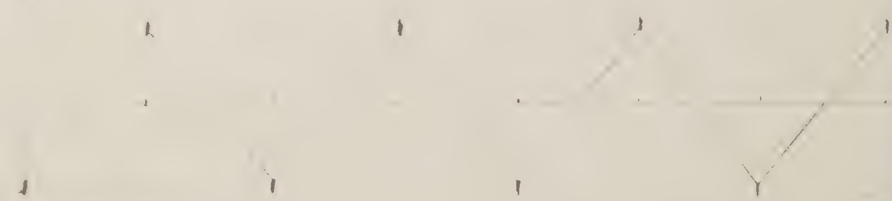
DIFFERENTIATING - 1000 C.P.S. - T.C. - 1/10 ALTERNATION



DIFFERENTIATING - 1000 C.P.S. - T.C. - 10 ALTERNATIONS

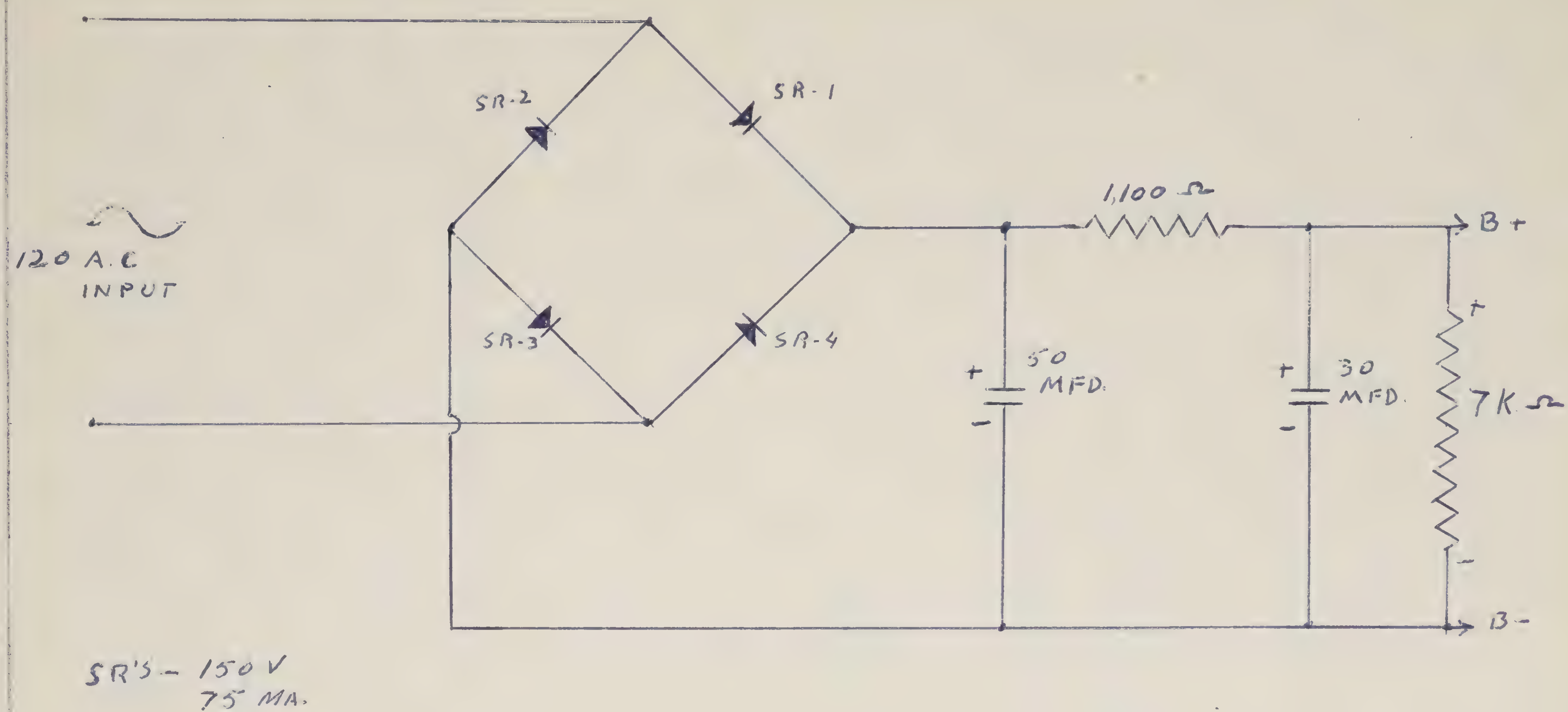


INTEGRATING - 1000 CPS - T.C 1/10 ALTERNATION



INTEGRATING 1000 CPS T.C - 10 ALTERNATIONS

LOS ANGELES TRADE-TECH. JR. COLLEGE	TITLE: INTEGRATING & DIFFERENTIATING	DATE
LOS ANGELES, CALIF.	DRAWN BY: LUCAS, AGUSTIN	10-15-56
ELECTRONICS CLASS	APPROVED BY:	



LOS ANGELES TRADE-TECH. JR. COLLEGE	TITLE: SELE. BRIDGE RECTIFIER	DATE
LOS ANGELES, CALIF.	DRAWN BY: A. LUCAS	10-23-56
ELECTRONICS CLASS	APPROVED BY:	

LUCAS, AGUSTIN

Los Angeles Trade Tech. Jr. College JS-
Instructor: R.H. Oeffinger

ELECTRONICS TECHNICIAN

JOB SHEET

Full-wave Rectification

Objective: How to test and service full-wave power supplies.

Materials: Obtain full-wave test power supply.

Equipment: Oscilloscope and voltmeter.

Procedure: Draw schematic of power supply --use drawing form.

Show with arrows the current flow for each half cycle of primary source.

Connect scope and voltmeter across output. Record voltage and waveforms for the following:

Connected as full-wave
475 volts

Amplifided

Half-wave
450 volts

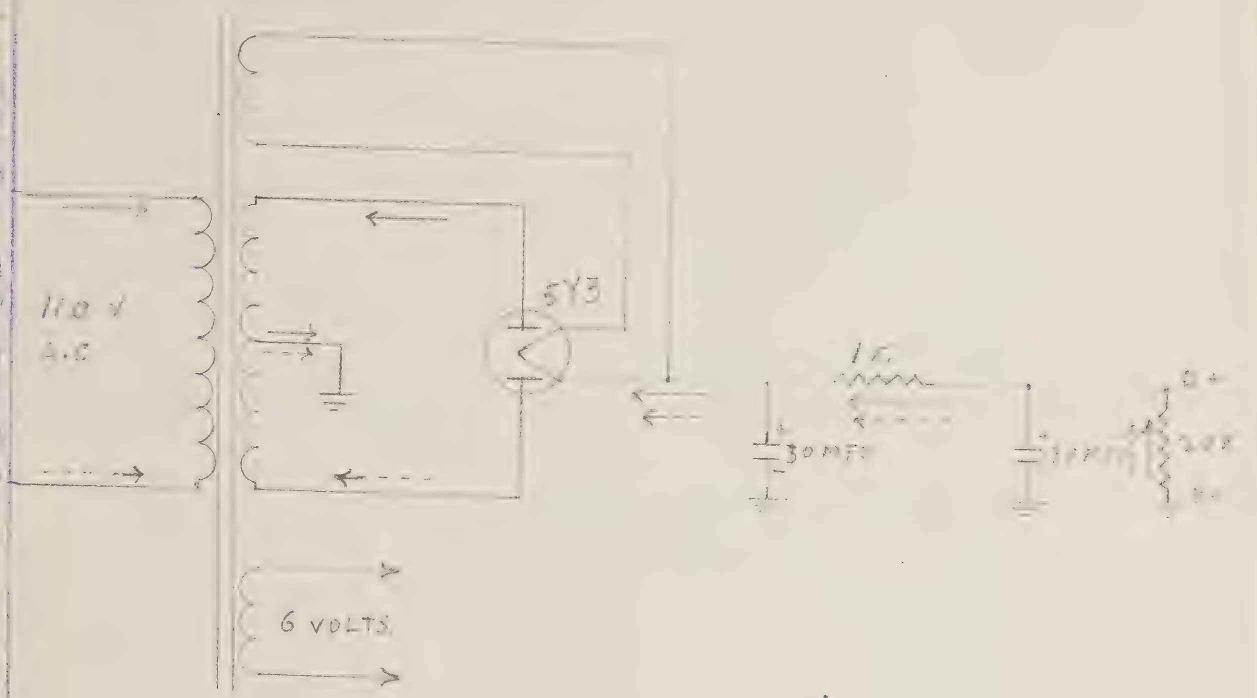
Summary Questions:

1. What is the ripple frequency at 60 cycles?
   120 c.p.s.

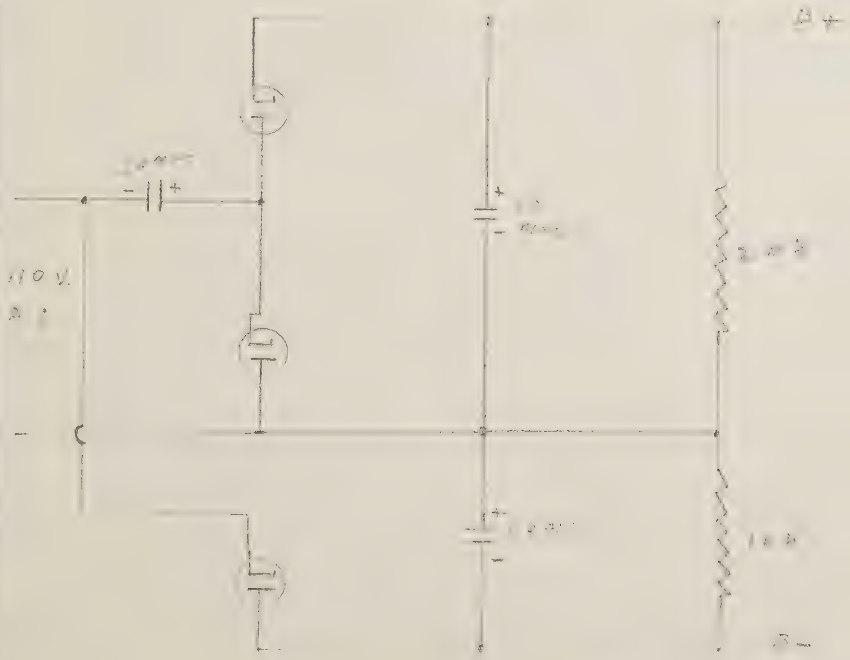
2. Which is the easier to filter, a half-wave or full-wave power supply? Why?
   Full wave. The ripple frequency is twice the half wave, therefore is easier to filter

3. Describe your method for determining a defective power transformer.
   By tacking voltage measurements it could be determine if any of the windings were open. By continuity checks it would show if there werd any shorted or open windings, also.

FULL WAVE RECTIFIER



VOLTAGE TRIPLER



LOS ANGELES TRADE-TECHNICAL COLLEGE
LOS ANGELES, CALIF.
FULL WAVE RECT. AND VOLT. TRIPLER
11-2-56

LUCAS, AGUSTIN

Los Angeles Trade Tech Jr. College JS-
Instructor: R.H. Oeffinger

ELECTRONICS TECHNICIAN

JOB SHEET

Voltage Doublers

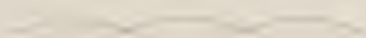
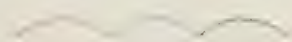
Objective: How to test and service voltage doublers.

Materials: Obtain half-wave and full-wave voltage doubler power supplies.

Equipment: Oscilloscope and voltmeter.

Procedure: Draw a schematic for each type(use form) and show the following: current flow with arrows, polarity on capacitors, and voltage output.

Connect oscilloscope and voltmeter to output and record voltages and waveforms for the following:

	Light Load	Heavy Load
Half wave	275 volts 	120 volts 
Full wave	300 volts 	250 volts 

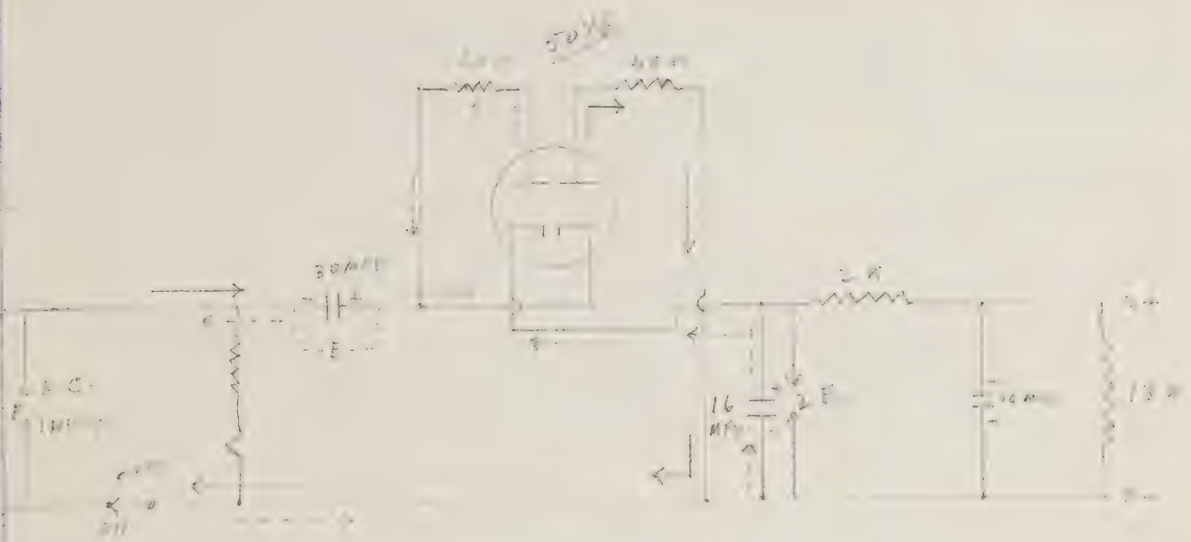
Summary Questions:

1. What component determines the voltage regulation in voltage doublers?
   The value of the capacitors

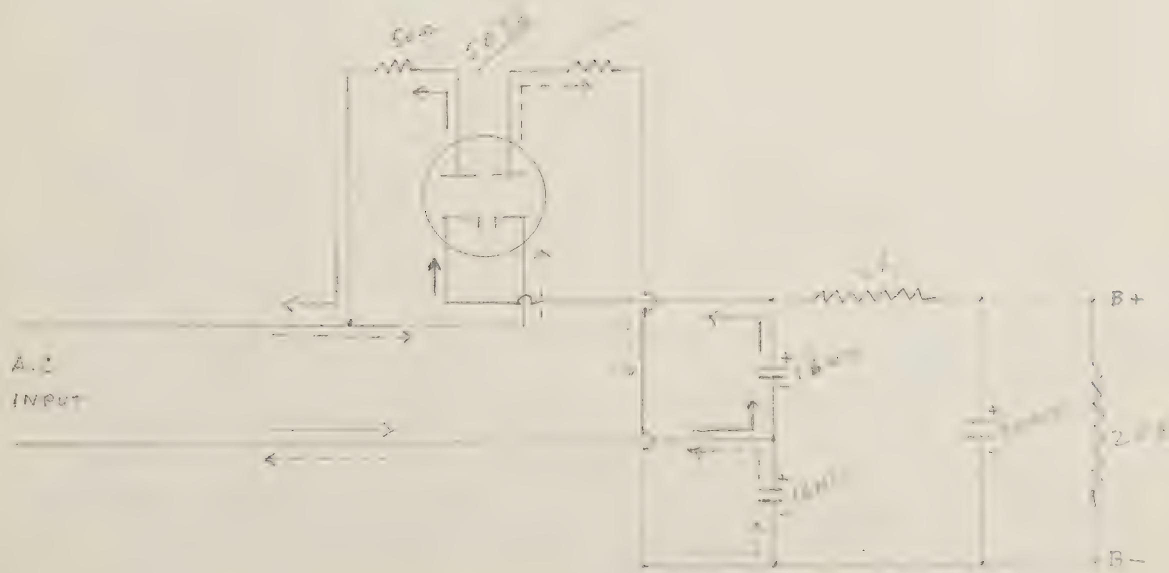
2. What types of electronic equipment are voltage doublers suitable to deliver power to?
   Low current-using devices

3. Draw a schematic of a voltage tripler.
   Drawn on separate form

HALF WAVE DOUBLER



FULL WAVE DOUBLER



LOS ANGELES TRADE TECHNICAL COLLEGE

LOS ANGELES, CALIF.

HALF AND FULL WAVE DOUBLERS

AGUSTIN LUCAS

LUCAS, AGUSTIN

Los Angeles Trade Tech. Jr. College JS-
Instructor: R.H. Oeffinger

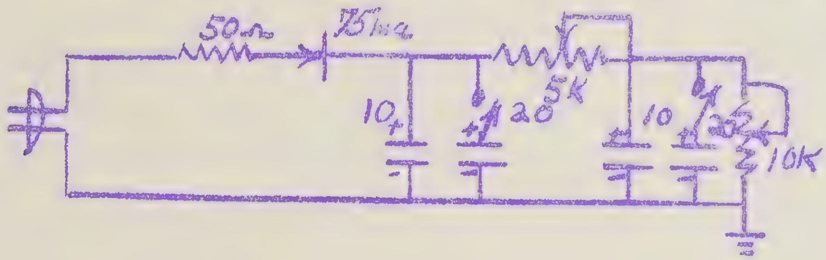
ELECTRONICS TECHNICIAN

JOB SHEET

Selenium Rectifier Power Supply

Objective: How to construct and study the characteristics of AC-DC half-wave selenium power supplies.

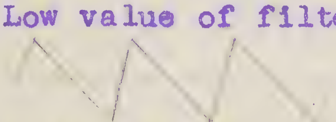
Materials: Parts and components to construct circuit as shown:



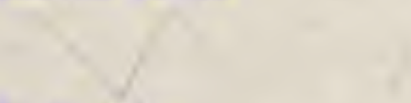
Equipment: Oscilloscope and voltmeter.

Procedure: Same as previous power supply:

I. Low value of filter resistor: 152 Volts



Medium value 125 Volts



High value 106 Volts

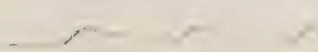
II. Low values of capacitance:

Input 130 Volts

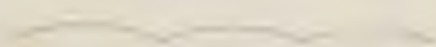
Output 122 Volts

High values of capacitance:

Input 165 Volts

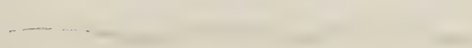


Output 157 Volts

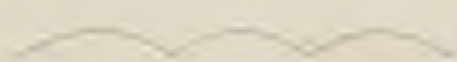


III. Change of load:

Light Load 152 Volts



Heavy Load 140 Volts



Job Sheet--Selenium Rectifier (cnt.)

Summary Questions:

1. Describe the action of a selenium rectifier.
The selenium rectifier will pass current in one direction, but offers a very high resistance in the other direction due to the combination of the seleneium coating on one side of the plates and the plates themselfs.

2. Calculate the voltage drop across the selenium for light and heavy load.
Values: Light load 20K Heavy load 10K Filter resistor 500 ohms
Voltage measurements across input cap. With load 152 Volts
Without load 170 Volts
Heavy load 140 Volts

152 ÷ 20K = 7.6 Ma. IN CKT
500 Ω X 7.6 Ma = 3.8 V. FILT. R.
152
170 − 155.8 = 14.2 VOLT DROP ACROSS RECT. W/ LIGHT LOAD

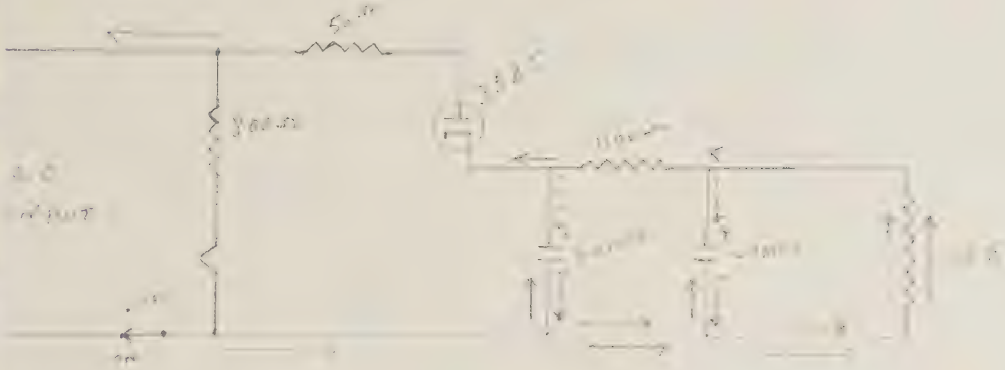
HEAVY LOAD

3. What are the advantages and disadvantages of selenium rectifiers?
Advantages: Do not need filament voltage supply
Disadvantages: Low inverse peak voltage
Low current-carrying ability
Temperature changes affect the backward resistance

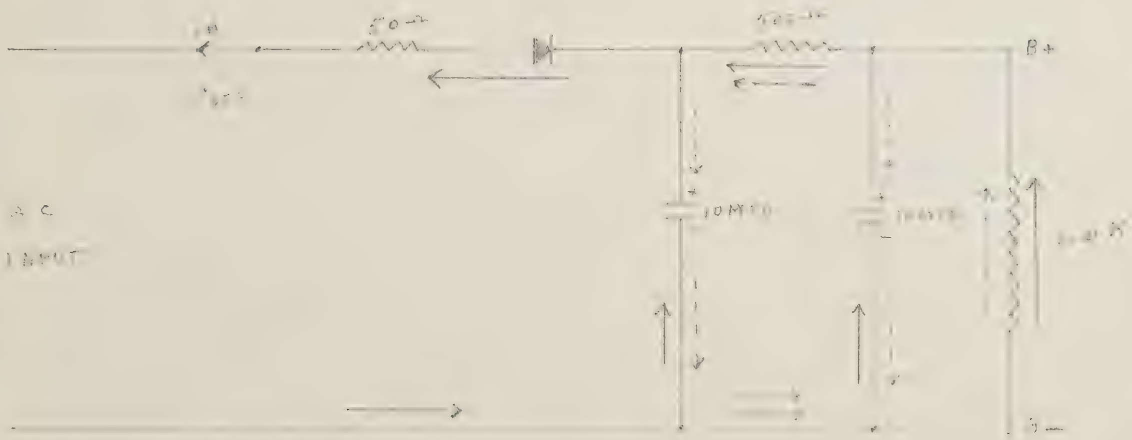
4. What is the proper method for checking a selenium rectifier?
Connect another in paralell with the one being checked and measure the output voltage. pa...

140 ÷ 10K = 14 Ma. IN CKT
500 Ω X 14 Ma = 7 VOLT. FILT. RES.
140
170 − 147 = 23 VOLT. RECT DROP

HALF WAVE RECTIFIER (TUBE)



HALF WAVE RECTIFIER (SELENIUM)



LUCAS, AGUSTIN

Los Angeles Trade Tech. Jr. College JS-
Instructor: R.H. Oeffinger

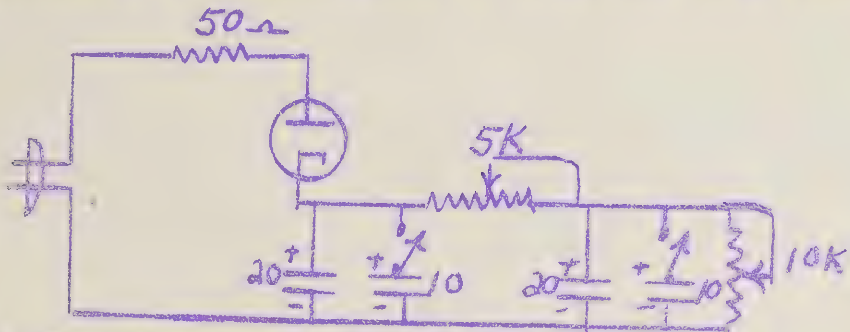
ELECTRONICS TECHNICIAN

JOB SHEET

Half-wave Rectifier--AC-DC Power Supply

Objective: How to construct and test half-wave AC-DC power supplies.

Materials: :Parts and components to construct the following circuit:

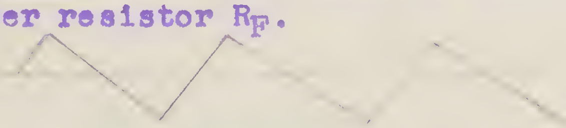


Equipment: Oscilloscope and voltmeter.

Procedure: Set R_L FOR RATED LOAD. Connect scope and voltmeter across load resistor. Record voltage readings and waveforms for the following conditions:

I. Low value of filter resistor R_F.

160 Volts



Medium value.

150 Volts

High value

140 Volts

II. Change values of capacitance and check voltage and waveforms across them:

Low values

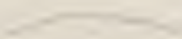
Input 165 Volts

Output 145 Volts

High values

Input 165 Volts

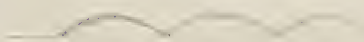
Output 140 Volts



III. Connect scope and voltmeter at output and vary load. Record voltage and waveforms.

Light Load 140 Volts

Heavy Load 86 Volts



Summary questions:

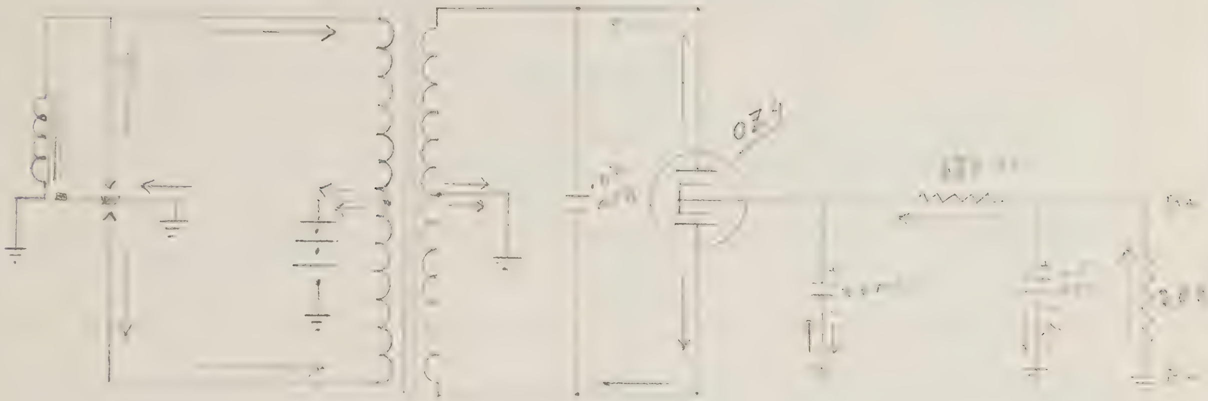
1. Why is this type of power supply called AC-DC?
   Because it can work either from an A.C. or D.C. source.

2. What is the relation between load and size of filter capacitors
   The size of the load will determine the value of the capacitors
   Heavy load-----Large capacitor
   Light load-----Small capacitor

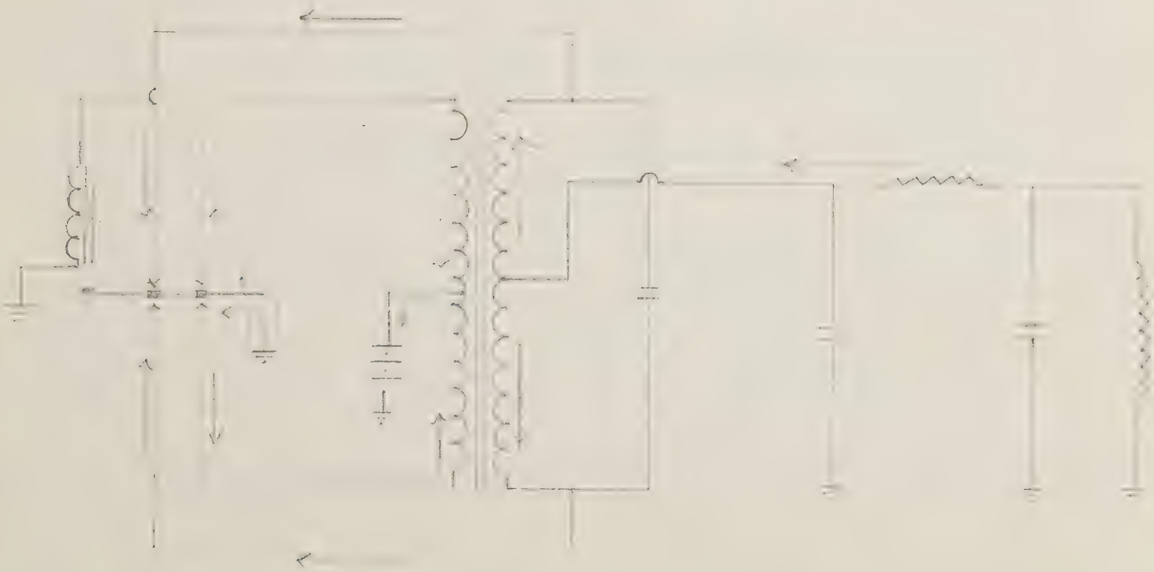
3. What is the relation between filter resistor and load?
   The size of load will determine the value of the filter resistor
   Heavy load----- Small resistor
   Light load-----Bigger resistor

4. What is the purpose of the 50 ohm resistor?
   To protect the tube from the surge of current when the filter capacitor starts charging.

NON-SYNCHRONOUS VIBRATOR



SYNCHRONOUS VIBRATOR



LUCAS AGUSTIN

ELECTRONICS TECHNICIAN

JOB SHEET

Vibrator Power Supplies

Objective: How to Test and Service vibrator power supplies.

Materials: Obtain synchronous and non-synchronous vibrator supplies, several sizes of buffer capacitors, and a bad vibrator.

Equipment: Oscilloscope and battery eliminator.

Procedure. Draw schematics of both power supplies (use form). With arrows show flow of current for each alternation.

Place oscilloscope across primary of the power transformer and observe waveforms.

Replace vibrator with bad one and observe waveform.

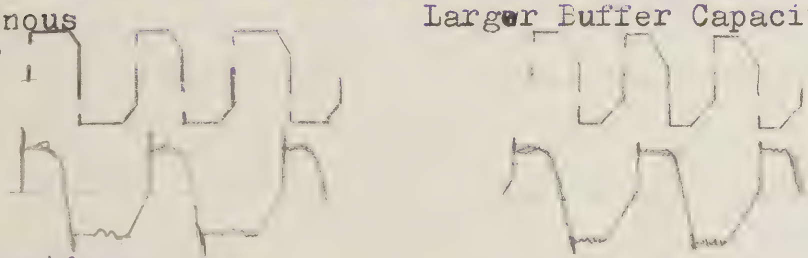
Shunt buffer capacitor with additional ones again observe waveforms.

Waveforms for vibrator and buffer capacitor checks:

~~Non~~-Synchronous Good Vibrator

Larger Buffer Capacitor

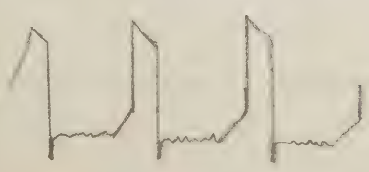
Bad Vibrator



Summary Questions:

1. What is the frequency of most vibrator power supplies?
   115 c.p.s.
2. What is the purpose of the buffer capacitor? To prevent the C.M.F. on the secondary from damaging the points of the vibrator
3. Explain your procedure for locating a short in first the the buffer capacitor and second the B+.
   First, pull out the rectifier tube. This will isolate the transformer from the B+ line. Next check with ohmmeter for shorts in the B+ components. If the buffer is shorted, after pulling out the tube the short will still show. The next step to disconect the buffer and see if the short is still in the power supply. Any component can be checked the same way .

On the now Synchronous Vibrator Supply, due to faulty vibrators this is the only wave form I was able to get.



[illegible] the buffer condenser. [illegible] the power contact period, A1 the inertia swing period, [illegible] contact period, and A2 the power swing period. Vibrator [illegible] across the primary of the power transformer.

[illegible] contact at point 2 opens an induced voltage set up by the [illegible] of the transformer would ordinarily create a high peak [illegible] and cause a burning arc to occur at the contact points. [illegible] this peak voltage charges the buffer condenser, which shock excites [illegible] circuit formed by the condenser and the effective inductance [illegible] oscillations is started at point [illegible] continue as shown by the dotted line, except that the enertia [illegible] closes at point 3 completely damping the rest of the oscillations. [illegible] 4 the opening of the enertia contact causes the same effect to take [illegible] for the other half of the cycle.

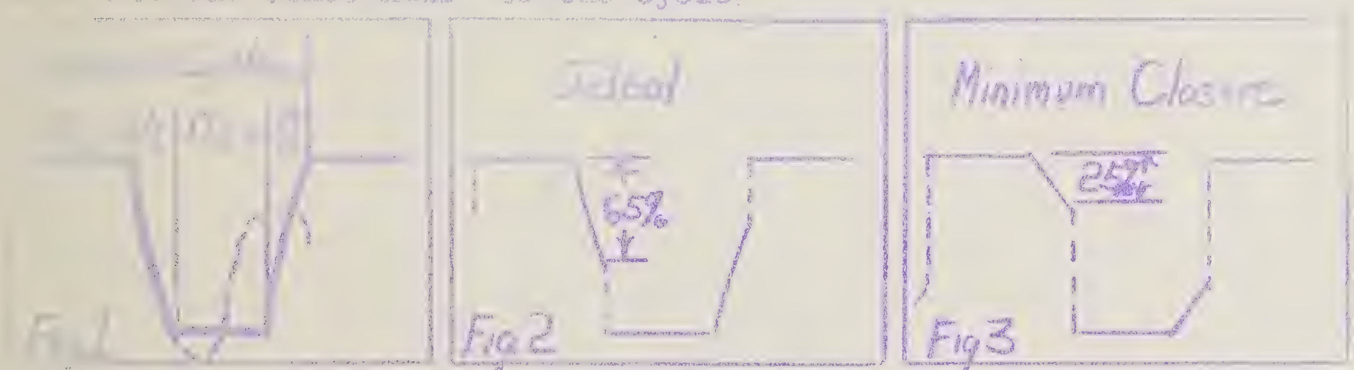


Fig 1 Fig 2 Fig 3

Fig. 2 illustrates the ideal practical value of choosing a buffer [illegible] to give 65% closure. Increasing the primary voltage also [illegible] % of closure(less time on contact period)and since the average [illegible] battery circuits vary from 5.5 to 7.5 volts, selecting a [illegible] [illegible] volts will compensate for this range. 25% is the [illegible] closure as shown in fig. 3.

(Page 2 - Vibrator waveforms)

Figs. 3b and 4 show overclosure caused most likely by worn contacts. (Worn contacts increase the swing of the reed thus prolonging the off-contact time).

When inertia contacts are entirely worn off the effect is known as "single-footing" and is shown in figs. 5 and 6.

Figs. 7, 8, and 9 are for conditions of vibrator contacts.

For fig. 10 remove the scope from the primary of the power transformer to the input filter condenser of the "B" supply.

Overclosure with B+ load

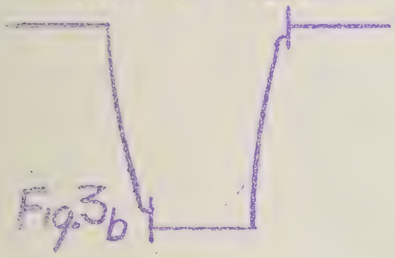


Fig3b

Overclosure no B+ load

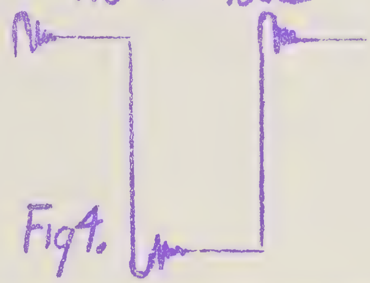


Fig4.

Single-Footing-B+ Load

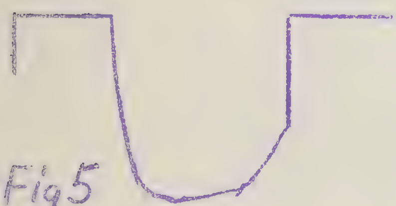


Fig5

Single-Footing No B+ Load

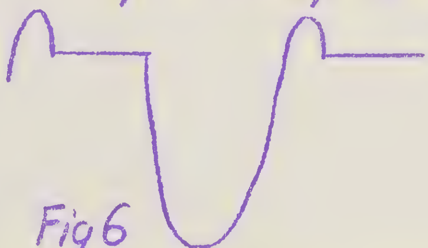


Fig6

Contact Roughness

Fig7

Contact Chatter

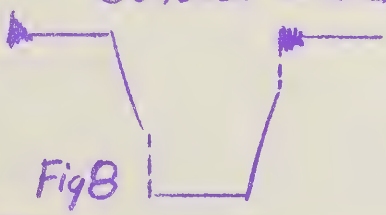


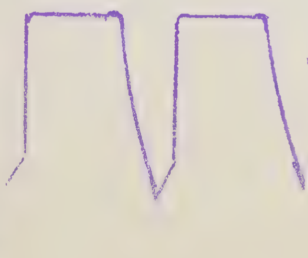
Fig8

Contact Bounce

Fig9

Fig 7+8 considered minor-

B+Ripple- Normal



Input Filter Condenser Open

Fig.10

LUCAS, A[illegible]

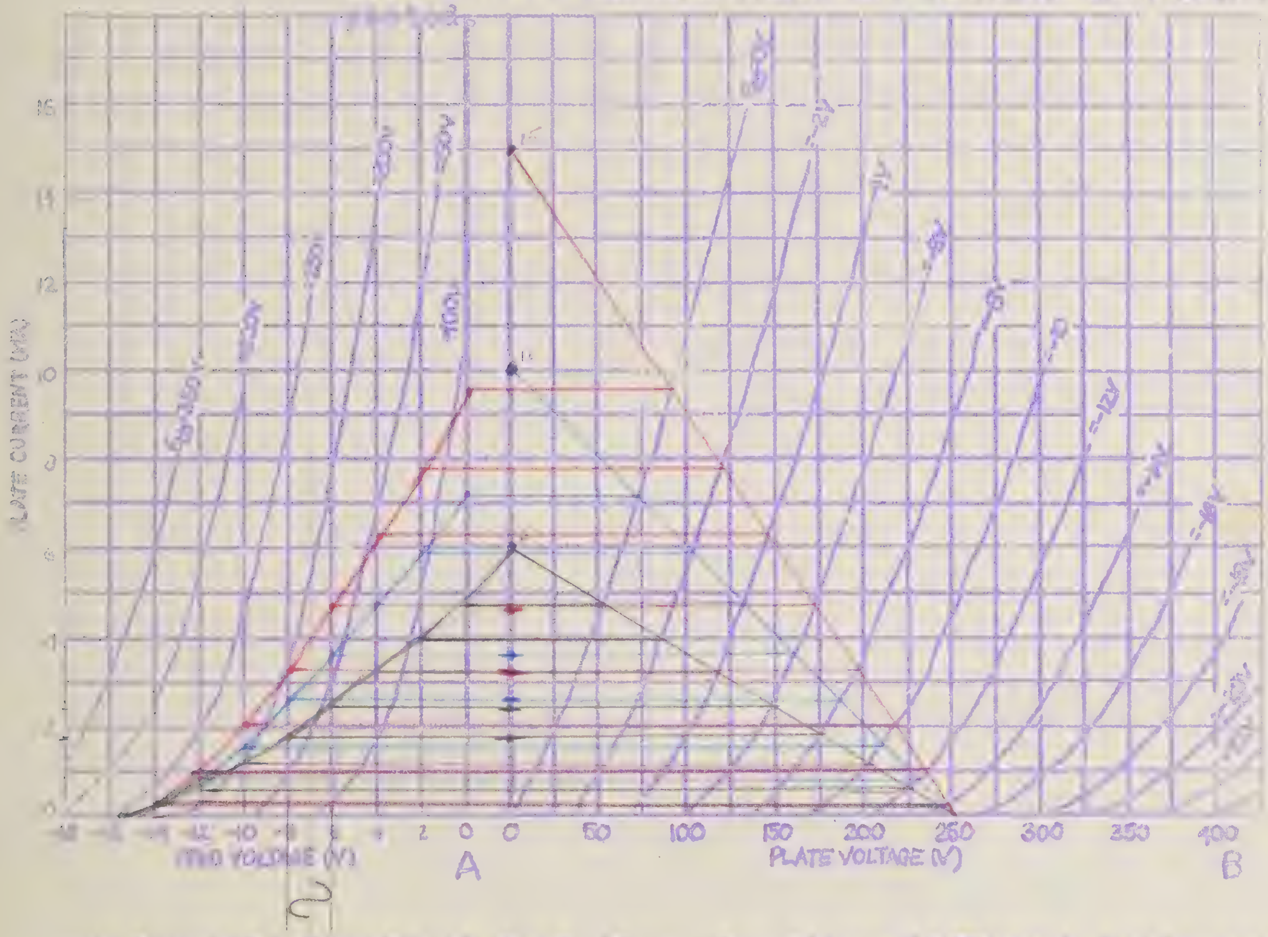
[illegible]

[illegible] TECHNICAL ASSIGNMENT SHEET

Load Lines

References: Principles of Radio--Henney; Electron Tubes--Army T.[illegible]

Introduction: The electronics technician that becomes employed in th[illegible] area of design of amplifiers (engineering aide) must understand the dynamic conditions that exist. The use of Load Lines will determine the results that can be ex[illegible]pected.



Assignment: Construct load lines for three different loads usi[illegible] 250 volt plate supply. Transfer all three to the grid characteristic chart.

A- 6 ma. 41.3 K. B- 10 [illegible] 25 K. C - 15 [illegible] 16.7 K.

Test:

1. What is the output signal for each load with an input sign[illegible] of 2 volts P.P. ? (choose bias for linear operation)

A = 30.8 VOLTS A- .75 ma Δ 41.3 K x .75 ma = 30.8 V. B = 1 ma Δ 25 K x 1 ma = 25 V.

B = 25 VOLTS C- 1.5 ma Δ 16.7 K x 1.5 ma = 25 V.

C = 25 VOLTS

2. What is the gain in each case?

A = 15.4 GAIN B = 12.5 GAIN C = 12.5 GAIN

3. With respect to gain, what is the general rule of the size of the load resistor?

TO A CERTAIN POINT, AS THE VALUE OF THE LOAD [illegible] [illegible] [illegible] [illegible] [illegible]

AGUSTIN LUCAS

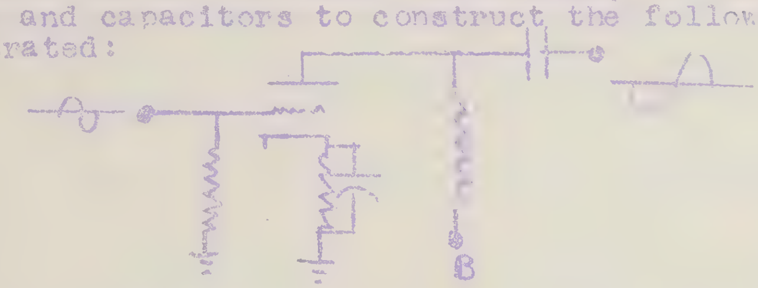
ELECTRONICS TECHNICIAN

JOB SHEET

Voltage Amplifiers--Triode

Objective: How to construct and measure performance of voltage amplifier and characteristics of vacuum tubes using the tube manual.

Materials: Resistors and capacitors to construct the following amplifier as illustrated:



Equipment: Oscilloscope, VTVM, and audio signal generator, and construction boards.

Procedure: Consult instructor for selection of four triode tubes to be used as voltage amplifiers.

With the aid of the tube manual construct one at a time a circuit for each tube using the circuit construction boards. Design and alter components for each circuit for maximum output with B+ supply available.

List the following characteristics for each tube:

1. Filament voltage.
2. Amplification factor.
3. Transconductance.
4. AC plate resistance.

Draw a schematic for each circuit and label the following:

1. B+
2. Values of components.
3. Plate voltage.
4. Bias voltage.(cathode)

List the following characteristics for each amplifier:

1. Voltage gain. (use 1000 cycles as standard)
2. Maximum undistorted input and output peak to peak voltage.

Summary Questions:

1. What affect on gain does increasing the size of the load resistor have? Why?
2. Describe the action and purpose of the cathode by-pass capacitor.
3. What affect will too small a coupling condenser have on the over all performance of the amplifier?
4. How is phase inversion accomplished in an amplifier?

VOLTAGE AMPLIFIERS JOB SHEET

SUMMARY QUESTIONS :

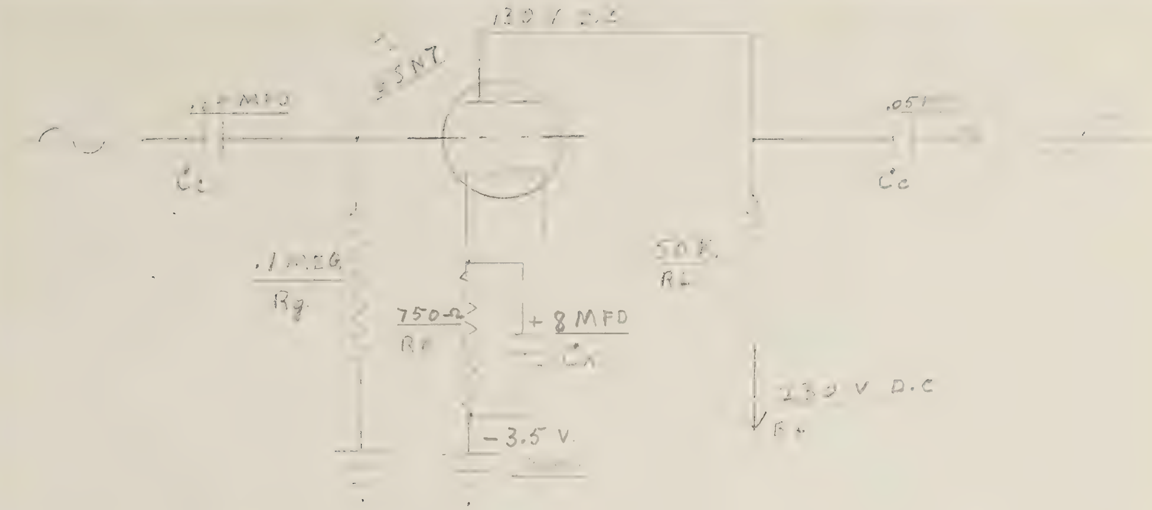
1. Increasing the size of the load resistor will increase the gain, because the"IpRL" drop will be greatter, therefore a greater change will be developed across RL.

2. The purpose of the cathode capacitor is to keep the voltage across the resistor (Rk) constant. To do this, the capacitor charges on the positive swing of the plate current change and discharges through the resistor on the negative swing.

3. Too small coupling capacitor will discriminate against the low frequencies.

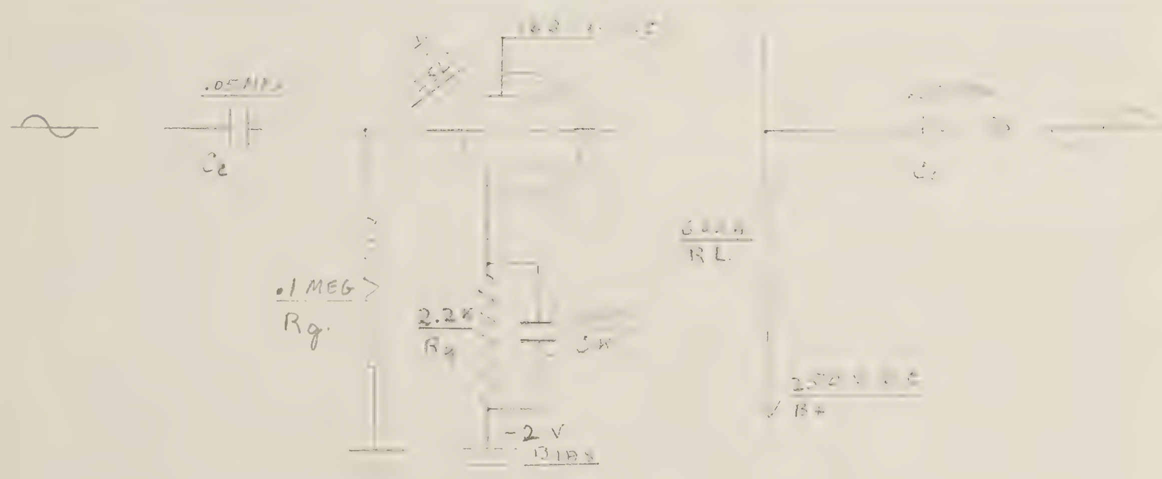
4. The plate voltage is 180 degrees out of phase with the signal voltage When the signal voltage goes positive more current flows in the plate circuit, therefore the plate voltage goes down and vice-versa. Giving 180 degrees phase inversion.

LOS ANGELES TRADE-TECH. JR. COLLEGE
LOS ANGELES, CALIF.
ELECTRONICS CLASS 6
TITLE: VOLTAGE AMPLIFIERS
DRAWN BY: AGUSTIN LUCAS
DEC-1-1956



TUBE CHARACTERISTICS:
Filament Voltage: 6.3
Amplification factor: 20
Transconductance: 2600 umhos
A.C. Plate resistance: 7.7 K.

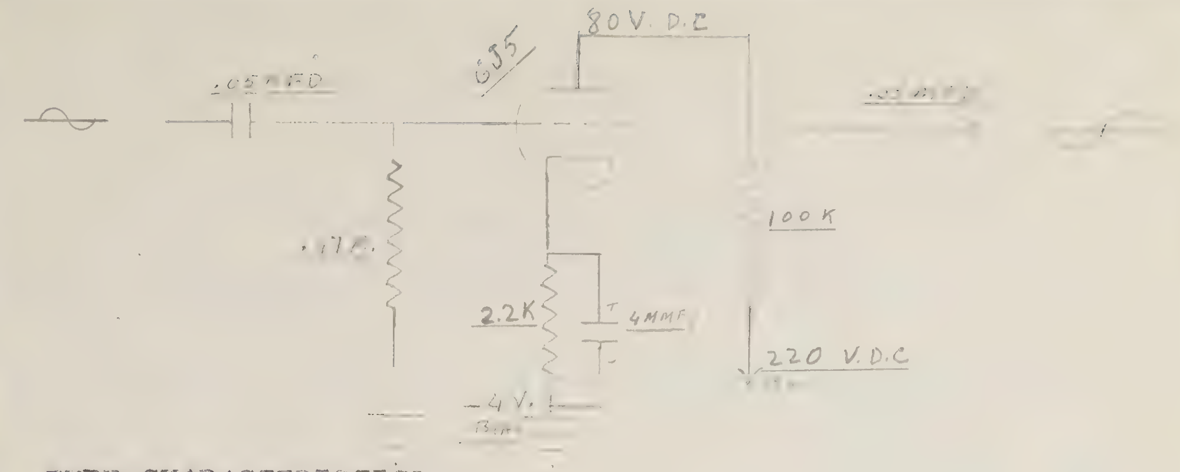
AMPLIFIER CHARACTERISTICS:
Input Signal: 5.5 Volts A.C. P. to P.
Output Signal: 77 Volts A.C. P. to P.
Gain: 14
Maximum undistorted input: 12 Volts A.C. P. to P.
" " output: 165 Volts A.C. P. to P.



TUBE CHARACTERISTICS:
Filament Voltage: 12.6 Volts
Amplification factor: 70
Transconductance: 1600 umhos
A.C. Plate resistance: 44 K.

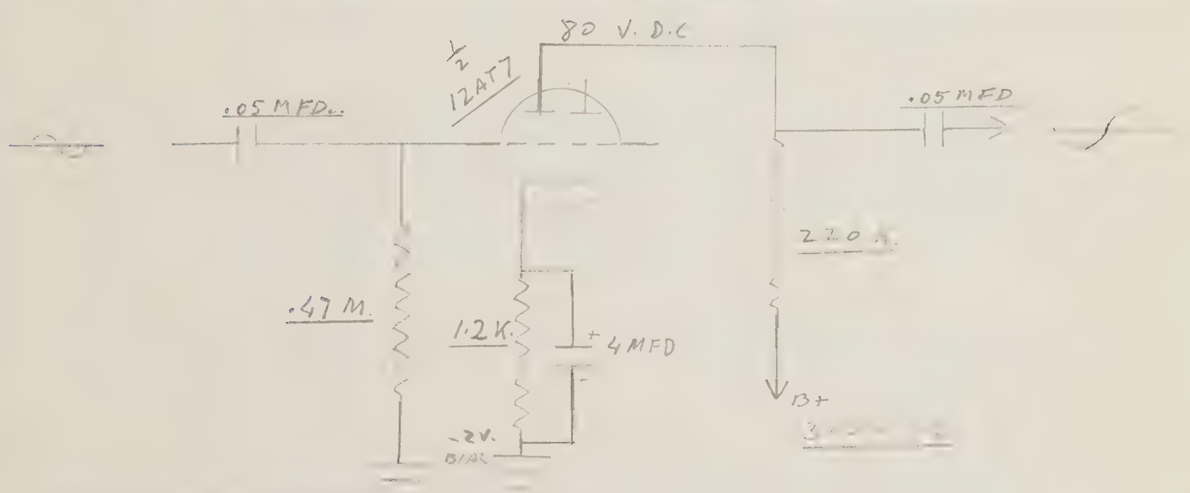
AMPLIFIER CHARACTERISTICS:
Input Signal: 3 Volts A.C. P. to P.
Output Signal : 113 Volts A.C. P. to P.
Gain: 37.6
Maximum undistorted input: 4 Volts A.C. P. to P.
" " output: 140 Volts A.C. P. to P.

School: Los Angeles Trade Tech. J.C. | Title: VOLTAGE AMPLIFIERS
Los Angeles California | Drawn By: AGUSTIN LUCAS
Class: Electronics | Approved By:
Date: DEC-1-1956



TUBE CHARACTERISTICS:
Filament Voltage: 6.3
Amplification Factor: 20
Transconductance: 2600 umhos
A.C. Plate resistance: 7.7 K.

AMPLIFIER CHARACTERISTICS:
Input Signal: 5.5 Volts A.C. P. to P.
Output Signal: 85 Volts A.C. P. to P.
Gain: 15.6
Maximum undistorted input: 15.5 Volts A.C. P. to P.
" " output: 198 Volts A.C. P. to P.



TUBE CHARACTERISTICS:
Filament voltage: 12.6
Amplification factor; 60
Transconductance: 5500 umhos
A.C. Plate resistance: 10.9 K.

AMPLIFIER CHARACTERISTICS:
Input signal: 3 Volts A.C. P. to P.
Output signal 85 Volts A.C. P. to P.
Gain: 28.3
Maximum undistorted input: 9 Volts A.C. P. to P.
" " output: 240 Volts A.C. P. to P.

Los Angeles Trade Tech. Jr. College
Instructor: R.H. Geffinger

AGUSTIN [illegible]
JS-

ELECTRONICS TECHNICIAN

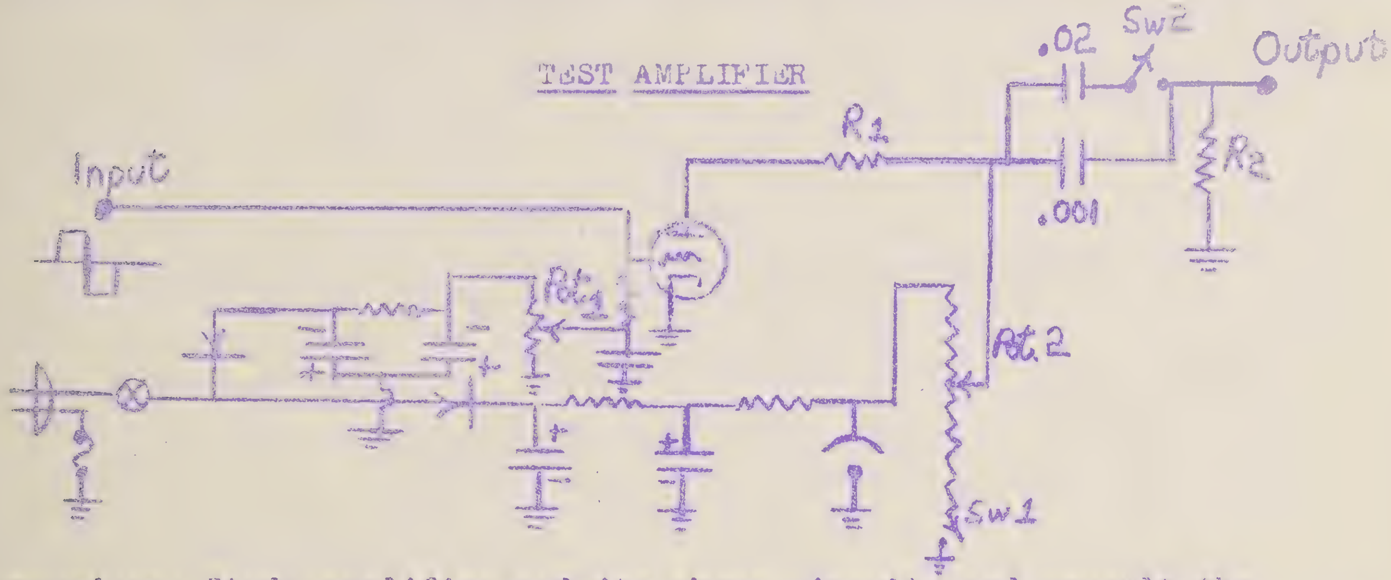
JOB SHEET

Vacuum Tube Characteristics

Objective: How to determine the characteristics of a vacuum tube and voltage amplifiers.

Equipment: Oscilloscope, voltmeter, square and sine-wave audio generator, and test amplifier.

TEST AMPLIFIER



Procedure: Study amplifier and its above circuit, and consult the instructor before going further. Instructor's OK [initials] (initial)
For the following use graph paper--log for freq. response.

✓ 1. Close Sw. 1, turn pot. 2 to B+ side, put voltmeter across R-1, and vary grid bias with pot. 1. With this information draw a grid characteristic curve.

✓ 2. From information obtained from above pick a grid bias voltage and vary pot. 2. From this draw a plate characteristic curve.

✓ 3. Open Sw 1, connect generator to inpit and oscilloscope to output. Vary grid bias, plate load, and the sine-wave output from generator at 1000 cycles. Draw waveforms for class A, B, and C. What effect is noticed by varying the plate load?

THE OUTPUT IS ALSO VARIED AND DISTORTED

✓ 4. Run a frequency resoonse and draw the curve. Use sine-wave output. Close Sw 2 and draw another response curve.

[illegible]. Change generator from sine-wave to square-wave at 500 cycles. Draw waveforms with Sw 2 open and closed.

Summary Questions:

1. What is the phase relation between input signal and output plate voltage and plate current?

   THE PLATE VOLTAGE IS 180° OUT OF PHASE WITH THE INPUT SIGNAL.
   THE PLATE CURRENT IS IN PHASE

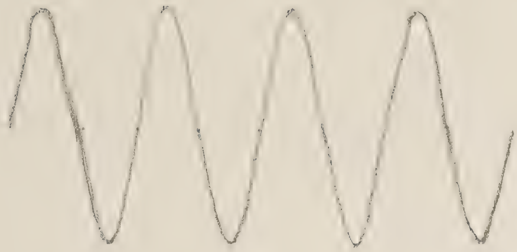
2. If an amplifier has poor high frequency response, what should a square-wave in the output look on the scope? Poor low frequency response?

   CURVES DRAWN ON SEPARATE SHEET.

3. What effect did the increase in the size of the coupling capacitor have on the frequency response?

   IT INCREASED THE RANGE OF THE FREQUENCY RESPONSE, EXPECIALLY AT THE LOW END.

INPUT – 1000 CYCLES



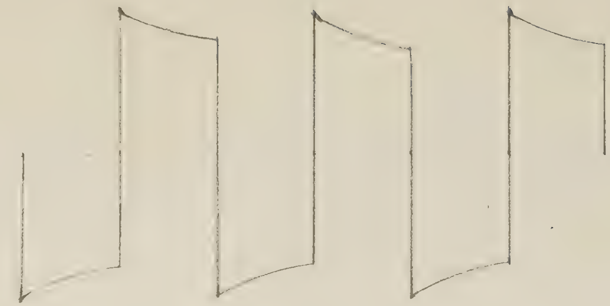
CLASS "A" WAVE FORM

CLASS B WAVE FORM

CLASS C WAVE FORM

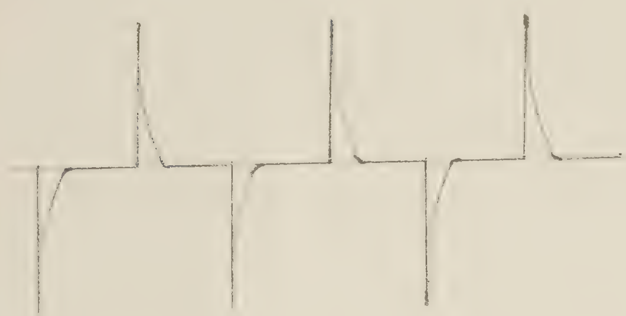
SQUARE WAVE INPUT 500 CYCLES

SW-2 OPEN SMALL C_c

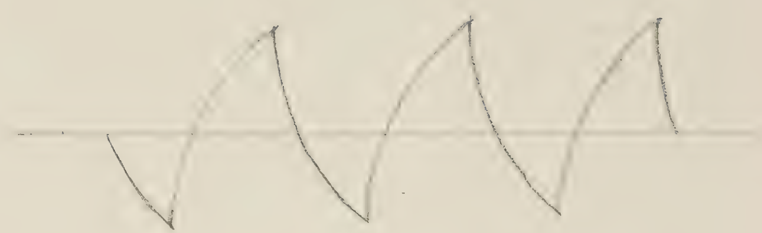


SW-2 CLOSED - LARGE C_c

FREQUENCY RESPONSE CURVES



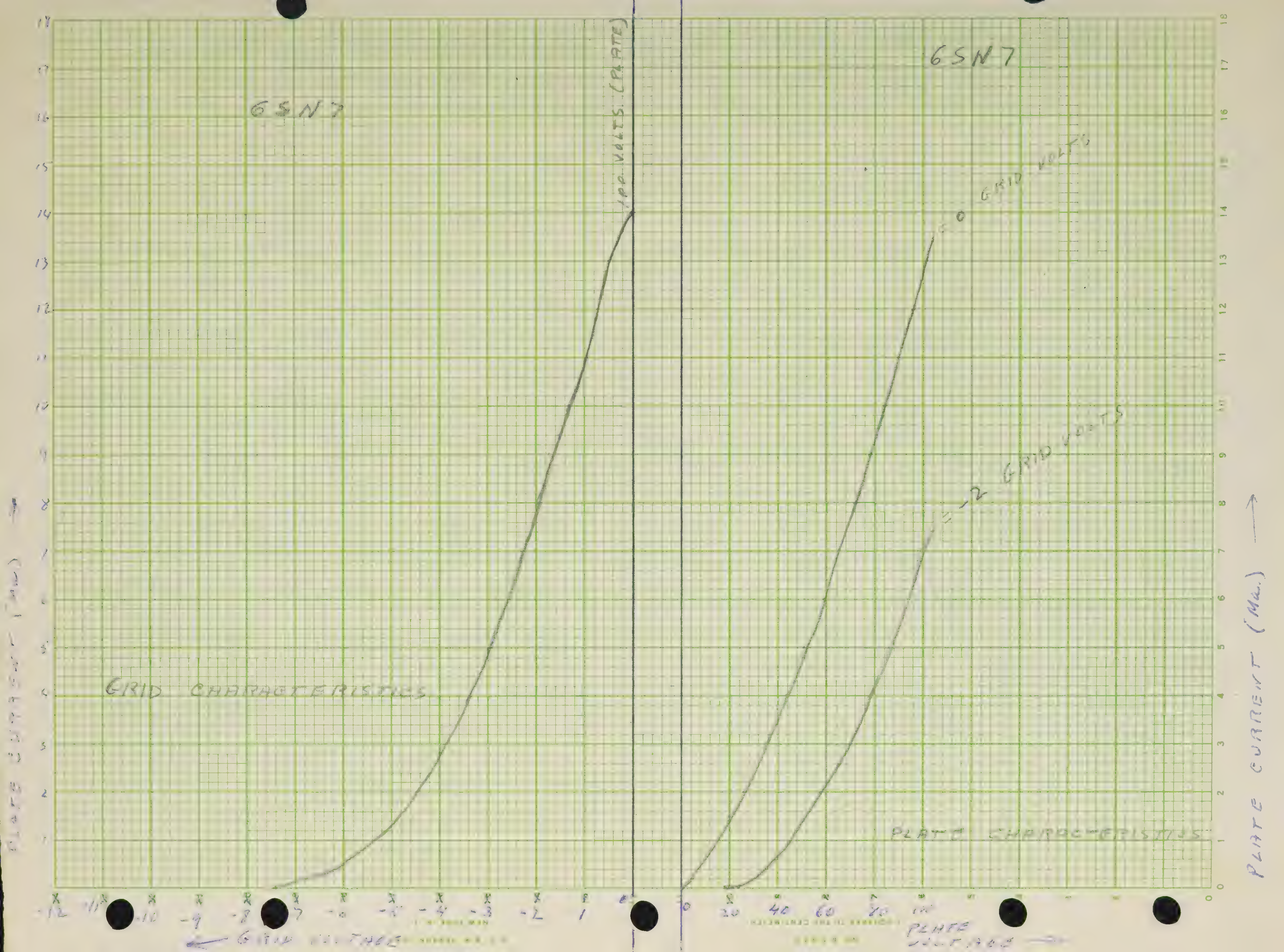
POOR LOW FREQUENCY RESPONSE



POOR HIGH FREQUENCY RESPONSE

JR. COLLEGE TITLE AMPLIFIER WAVE FORMS

DRAWN BY AGUSTIN LUCAS JAN-3-1957


6SN7
6SN7
GRID CHARACTERISTICS
PLATE CHARACTERISTICS
100 VOLTS (PLATE)
0 GRID VOLTS
-2 GRID VOLTS
PLATE CURRENT (Ma.)
PLATE CURRENT (Ma.)
GRID VOLTAGE
PLATE VOLTAGE

Agustin Lucas
Jan-23-57

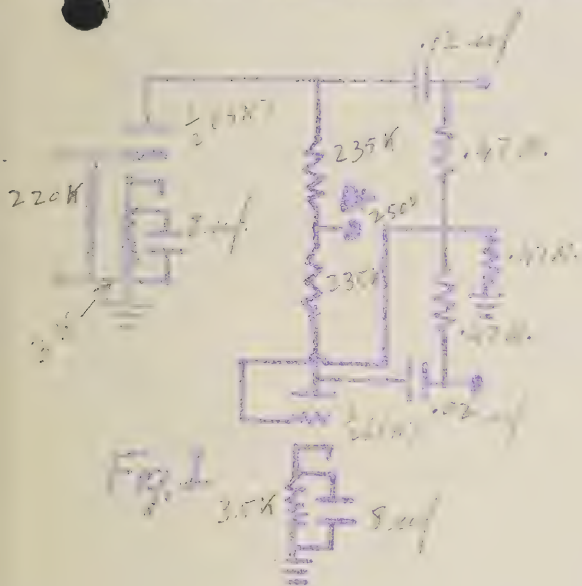
ELECTRONICS TECHNIC 54

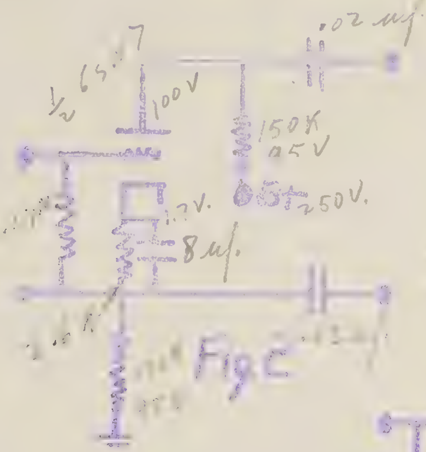
JOB SHEET

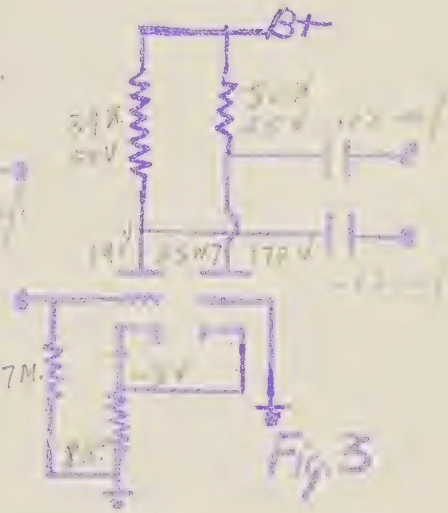
Phase Inverters

Objective: How to recognize, test and measure the performance of standard phase inverter circuits.

Materials: Components and parts to build the following circuits:







Equipment: Audio generator, Oscilloscope and VTVM.

Procedure: With the aid of tube manuals, references, notes and calculations determine the value of each component. Label each circuit and value of each component.
Insert signal of proper value from generator. With oscilloscope determine the amplitudes of both outputs for each type. Check to see that they are equal.

Summary Questions:

1. What is the chief purpose of phase inversion?

   To obtain two signals of equal amplitud and 180° out of phase so they can be fed to a push-pull stage.

2. If there is no signal from one of the outputs of a phase inverter, what would the signal look like in the output stage?

   A wave of smaller amplitude

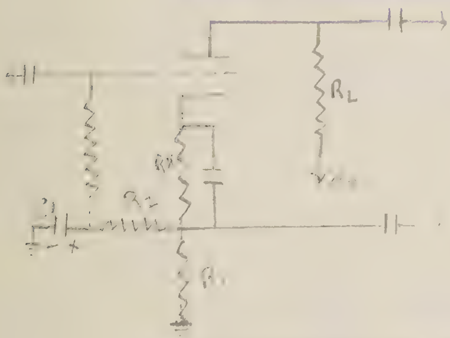
3. Explain in detail how phase inversion is accomplished in each type used in this job sheet.

Fig. 1 Self balancing: On this type, phase inversion is accomplished by using two tubes, one acts as an amplifier and the other as the phase inverter. The output of both tubes flows trough a voltage divider composed of the grid resistors of the push-pull stage connected to ground through a common resistor. The voltage drop across this resistor is the algebraic sum of both outputs and it is the imput signal to the phase inverter. If the output of the amplifier varies, this voltage will vary in proportion, changing the output of the phase inverter to the same amplitud but 180 degrees out of phase.

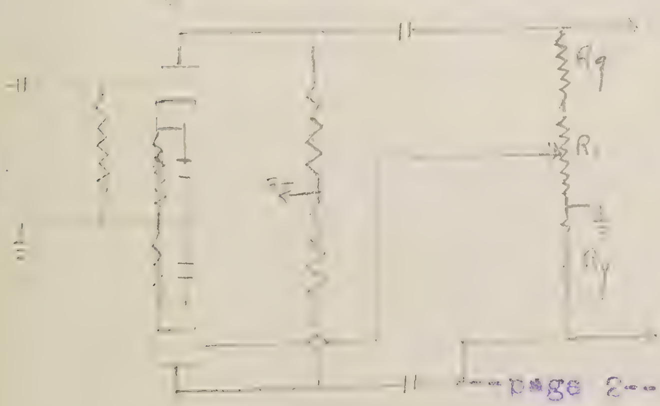
Fig. 2 Split load: On this type, phase inversion is accomplished by splitting the load of the tube. One output is taken off like from a staight amplifier, the other is taken from the second half of the load, which is in series with the Rk. Since the plate current flows trough both equal RL in series both outputs are equal, and 180° out of phase because, one is taken from the negative side of the load and the other from the positive side.

Fig. 3 Grounded grid: Phase inversion is done by a duo triode or or 2 triodes. Both cathodes are connected to ground by a common unbypassed resistor. The grid of the phase inverter is grounded placing it at a more negative potential than the cathode. The voltage across the Rk is deveoped by the algebraic sum of both plate currents and it is the signal applied to the inverter. Since the cathode potential will be changing at the same time that the amplifier grid, the action of the tube will be reversed giving an output which is 180° out of phase. If the Rk is the proper size it should give a voltage with an amplitud which is half the amplitud of the voltage applied to the amplifier grid.

4. Describe and draw the schematics for two other methods of phase inversion:



4. This is a variation of the split load inverter to permit a grounded input. R1, R2 and C1 form a paralell circuit as far as the signal is concern therefore R1 and R2 must be equal and double the size of RL. C1 mustbe fairly large to pass all the audio frequencies.



5. This is a variation of the self balancing inverter. This inverter must be balanced manualy. The signal input for the inverter is taken off the "pot" R1, which is part of a voltage divider. The amount of voltage taped must be adjusted so that the output of the inverter is of equal amplitud that the output of the amplifier.

--page 2--

Agustin Lucas
Jan-23-57

ELECTRONICS TECHNICIAN

JOB SHEET

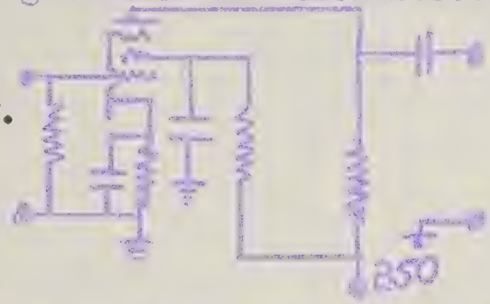
Pentode Voltage Amplifier

Objective: To calculate practical values of components for pentode voltage amplifiers, and be able to construct and test.

Materials: To construct amplifier as shown.

Equipment: Audio generator and oscilloscope.

Input .4 P.to P.
Output 100 P. to P.
Gain 250



Rg---.47 Meg.
Rk---560 Ohms
Rsc.-.4 Meg.
RL---125 K.
Ck---8 ufd.
Csc--.22 ufd.
Cc---.05 ufd

Procedure: Select one of the following tubes to construct the above amplifier: 6SJ7, 6SK7, 6AU6, and 6AG5.

With aid of tube manual design circuit to give the maximum output with a supply of 250 volts.

Connect audio generator to input and oscilloscope to output. Determine maximum V.G. --undistorted.

Raise voltage on screen by parallel resistor across screen resistor--check V.G. Increased

Summary Questions:

1. Why do pentodes have a high plate resistance? Because a greater change in plate voltage is needed to produce a small change in plate current.
2. What is the range of amplification factor of pentodes?
Up to 1500

3. Compare Triodes and Pentodes as follows: advantages, disadvantages, and characteristics.
The main advantage of the pentode over a triode is the lower interelectrode capacitance and greater amplification. Also in a pentode amplifier a smaller input signal can be used, due to the fact that the control grid has more control on the plate current. The pentode has more distortion than a triode because of a smaller linear portion in the characteristics curve. (Eg Ip)

AGUSTIN LUCAS

ELECTRONICS TECHNICIAN
JOB SHEET

The Decibel

Objective: How to use decibels.

Materials: Load resistor for amplifier.

Equipment: Audio amplifier, audio oscillator, and AC voltmeter.

Procedure: Insert ½ volt signal into amplifier and calculate power input and output. Use 1000 cycles as standard.
Repeat above for 1 and 1½ volt input.

R = 1M.

$\frac{1}{2}$ V. INPUT $- P = \frac{E^2}{R} = \frac{.5^2}{10^6} = .25\ \mu w$; OUTPUT 5.8 V. $R = 8\ \Omega$ $\frac{5.8^2}{8} = \underline{4.205\ W}$

1 V INPUT $- \frac{1^2}{10^6} = 1\ \mu w$; OUTPUT 7.7 V R. $8\ \Omega$ $\frac{7.7^2}{8} = \underline{7.41\ W}$

$1\frac{1}{2}$ V. INPUT $\frac{1.5^2}{10^6} = 2.25\ \mu w$; OUTPUT 8.5 V R. $8\ \Omega$ $\frac{8.5^2}{8} = \underline{9.03\ W}$

Calculate the db gain for each case.

GAIN

1 - $DB = 10 \text{ Log } \frac{4.2}{2.5 \times 10^{-7}} = \text{Log } 1.68 \times 10^7 = 7.2253 \times 10 = \underline{72.22\ DB}$

2 - $DB = 10 \text{ Log } \frac{7.41}{10^{-6}} = \text{Log } 7.41 \times 10^6 = 6.8698 \times 10 = \underline{68.7\ DB}$

3 - $DB = 10 \text{ Log } \frac{9.03}{2.25 \times 10^{-6}} = \text{Log } 4.01 \times 10^6 = 6.6031 \times 10 = \underline{66.03\ DB}$

Summary Questions:

1. What is the difference between db and dbm?
   DB is used with reference level of .006 watts - [illegible]
   DBM " " " " " " .001 " - 600 Ω
2. An amplifier has a rated output of 20 watts, what is the db gain with a 6 milliwatt zero reference?
   $DB = 10 \text{ Log } \frac{20}{.006} = \text{Log } 3333.33 = 3.522 \times 10 = \underline{35.22\ DB}$
3. What is the wattage output of a device with a gain of -15dbm?

$-15\ DBM = 10 \text{ Log } \frac{X}{.001} = (-1.5 = \text{Log } \frac{X}{.001})$ ANTILOG 1.5 = .316

$\frac{X}{.001} = .316$; THEN $X = .001 \times .316 = \underline{316\ \mu w}$

.316
.20
.06320

AGUSTIN LUCAS

Los Angeles Trade Tech. Jr. College
Instructor: H.B. Oeffinger

JS-

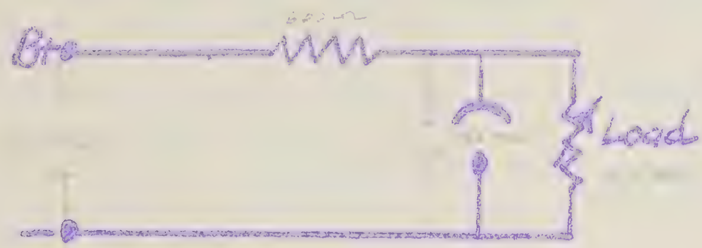
ELECTRONICS TECHNICIAN

JOB SHEET

Voltage Regulation--Glow Discharge

Objective: How to test, measure and construct voltage regulators.

Materials: To construct a voltage regulator as shown:



Equipment: Power supply, VTVM, and oscilloscope.

Procedure: Construct voltage regulator for a load within the range of the power supply and regulator tube.

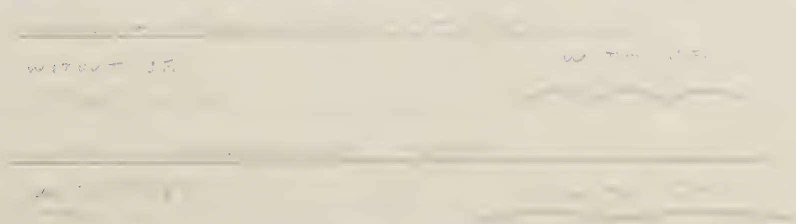
Vary load and measure voltages:

3K = 90 V - VR TUBE OUT

Vary AC input to power supply and record voltage output:

100 V IN — VR TUBE OUT — 100 V OUT
110 V " " " IN — 110 V "
120 V " " " " — 110 V "
130 V " " " " — 110 V "

Connect oscilloscope to output of regulator. Vary filtering by removing a filter capacitor. Record waveforms of the effect that a regulator has on a DC ripple:



Job Sheet--Voltage Regulation-Glow Discharge

Summary Questions:

1. Give your explanation of the characteristics of a glow discharge tube.

The amount of ionization of the gas in the tube varies with the amount of current that the tube conducts. If a high current is passed, the gas is highly ionized and the resistance of the tube is low, and vice-versa, therefore keeping the voltage across the tube fairly constant over awide range of current.

2. How is the value of the series dropping resistor determined?

$R = \frac{E}{I}$. The voltage droped across the resistor must be the difference between the input voltage and the rated voltage across the tube. The current used in the calculations is the maximum rated current of the tube.

3. To what type of circuits for regulation are the discharged tubes limited?

The VR tube is limited to low current circuits, since they are rated at a maximum of 30 Ma.

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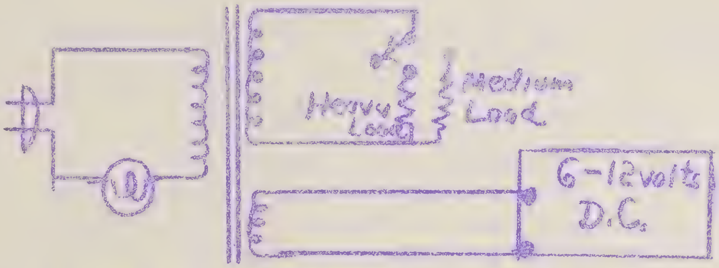
JOB SHEET

TRANSFORMER LOADING

Objective: How to understand the effects produced when a transformer is loaded.

Equipment: Power transformer demonstration unit and battery eliminator.

Procedure: Connect equipment as shown:



Plug in unit and observe lamp. Load up secondary with light and medium loads. Insert a DC current into one of the low voltage secondary windings. Increase current flow from DC supply until there is no effect noticed between a loaded or unloaded secondary winding.

Summary Questions:

1. Why is lamp dim with no loaded secondary?
(The power in the primary must equal the power in the secondary). If the secondary is open (no load) there is no current flowing, therefore no power is being consumed in either winding, so the lamp on the primary is dim.

2. Why does lamp increase with a loaded secondary?
With a loaded secondary there is current flowing and power is being consumed. The lamp lights brightly in the primary. If the load is incraesed, more current will flow and the light will also increase.

3. Why did the load have no effect on the lamp when a DC current was sent through one of the other windings?
The D.C. current sets up a stationary magnetic field, which saturates the iron core and eliminates the induction effect of the primary. In this case the only impedance to the source is the low D.C. resistance of the primary, producing a heavy current flow. Changing the load on the secondary has no effect on the lamp since there is no mutual induction between the two windings

Los Angeles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

ELECTRONICS TECHNICIAN

JOB SHEET

Impedance

Objective: How to measure and calculate the effects of reactive circuits when resistance has been included.

Materials: Obtain test board for circuits illustrated.

Equipment: AC voltmeter.

Procedure: Apply 60 cycle line voltage to each circuit. Measure the voltage across each component and the line voltage. Measure the value of the resistor. Record all measurements for future use.

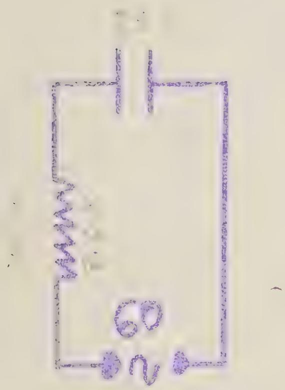


Fig.1

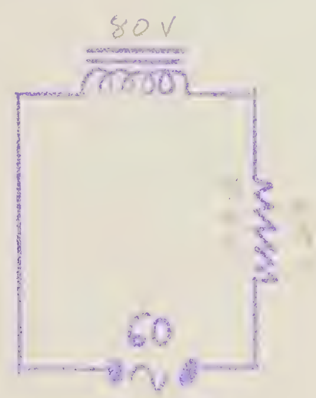


Fig.2

SHOW ALL WORK

Summary Questions:

1. From the voltage readings obtained show with vectors and calculations the resultant line or applied voltage.

2. What is the current value for each circuit?

3. What is the Z of each circuit?

4. What is the value of L and C?

$X_C = \frac{1}{\omega C} = C = \frac{1}{\omega X_C} = \frac{1}{\ldots} = .27$ MFD. $= C$

$X_L = \omega L = L = \frac{X_L}{\omega} = \frac{10^4}{376.8} = 26.6$ HENRY $= L$

5. What is the value of the capacitive reactance?

$X_C = 9.77\ K\Omega$

Los Angeles Trade Tech. Jr College
Instructor R.H. Oeffinger

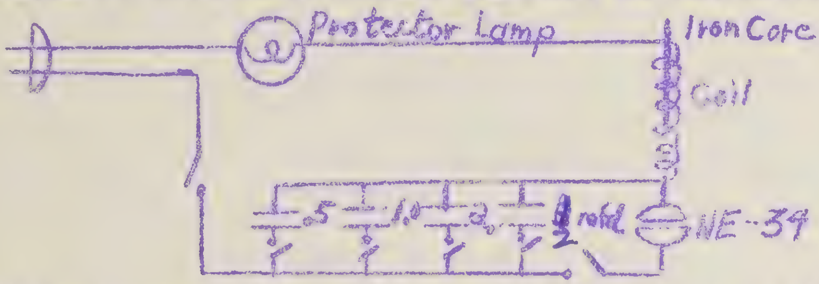
JS--
Agustin Lucas
April 11 1957

ELECTRONICS TECHNICIAN
JOB SHEET

Series Resonance

Objective: To demonstrate the effects of inductance and capacitance in resonant circuit.

Materials: Prepared series resonant circuit as illustrated:



Procedure:

Caution: Open line switch each time when adding capacitance on capacitor bank. Coil should be kept 1.25 inches above base.

1. a. Connect a 2 mfd capacitor and close line swith.
   b. Repeat with NE 34 lamp connected across capacitor bank. Note intensity of lamp.
   c. With NE 34 connected remove core from coil observing the effect on the lamp.

2. Repeat 1 with 3mfd capacitance connected.

3. Repeat 1 with 5mfd capacitance connected.

Report: (Prepare sepate technical report)

1. Explain action of the oscillating iron core.

2. Explain action of the core coming to rest.

3. Give your reson for the change of light intensity for each case.

4. What effect did removing the core from the coil have on its inductance? From the reaction on the light, what effect did it have on the circuit?

Los Angeles Trade Tech. Jr. College
Instructor: R. H. Oeffinger

TR-
Technician: Agustin Lucas

Date: April 11 1957

ELECTRONICS TECHNICIAN

TECHNICAL REPORT

Title: Series resonance

This report contains the information gathered with the demonstrator board on series resonant circuits.

The circuit was found to be nearest resonance with a 2 mfd. capacitor and the core out of the coil. The voltage across both reactances was almost equal. The current in the circuit is at maximum.

When the core was inserted in the coil the intensity of the lamp NE-34 across the capacitor,decreased slightly, indicating a decrease of the current in the circuit. With the core inserted in the coil, the inductance and reactance were increased, therefore detuning the circuit and decreasing the current.

With the circuit set at resonance and the core outside the coil resting on the board, the line switch was closed. At that instant, a strong magnetic fiel was set up by the coil. since maximum current is flowing. This magnetic field atracted the core into the coil with great force. As the core entered the coil, it's inductance increased, the circuit is detunned and the current decreased. Now, when the core was atracted to the coil it's momemtum carried it to the other side, so that as it was moving out the inductance of the coil was decreasing bringing the circuit back towards resonance and again increasing the current which in turn increased the atraction by the coil to the core. This increased atraction plus the core's own weight, sended it back down through the coil bringing the circuit back to the original position. This process of oscillations continued on a dampening motion until the core came to a complete stop inside the coil. Since the core never comes out of the coil completly, the circuit never reaches the resonance point. On each oscillation the current decreases more and more until the core losses all it's momemtum and the changing magnetic field, changing at the line frequency, is able to hold it steady in the coil.

The lamp NE-34 across the capacitor varied in intensity as the core moved in and out of the coil, being brighter at the top and bottom of each oscillation, indicating the changing current in the circuit as it aproached resonance.

Removing the core from the inductance decreases it's inductance since the iron offers less reluctance to the flux lines than air. The lamp indicated an increase in current by being brighter, proving that the circuit was at resonance with the core out.

Increasing the capacitance, also detunes the circuit since the Xc is decreased. Closing the line switch with the capacitance increased, the core is atracted to the coil like in the first case, but now the current is much less, and the magnetizing force is not enough to hold the core in the coil due to the gravitational force in the core, so it keeps oscillating

Los Angeles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

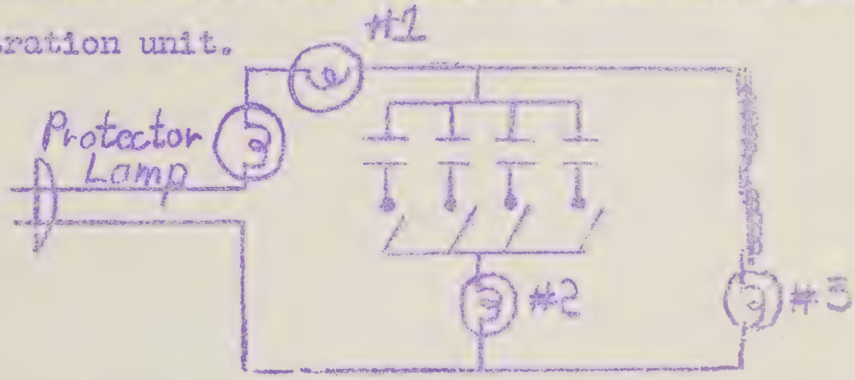
JS--
Agustin Lucas
April 15 1957

ELECTRONICS TECHNICIAN

Job Sheet
<u>Parallel Resonace</u>

Objective: To understand the characteristics of parallel resonance circuits.

Materials: Prepared demonstration unit.



Procedure: CAUTION: Switch 1 should always be opened before adding capacitance. Make certain that iron cores are in the coils before applying voltage.

1. With the capacitance branch out of the circuit, close sw-1, observe the current indicating lamps.

2. Repeat #1 with 4.5 mfd, observe the intensity of lamps 1, 2, and 3.

3. Repeat #1 with 5.5 mfd, observe the intensity of lamps 1, 2, and 3.

Report: 1. Write a technical report explaining the results observed in steps 1, 2, and 3.

2. What would happen if the line voltage was applied without the iron cores in the coils?---Why?

3. At resonance, why does lamp #1 remain lighted a small amount?

Agustin Lucas

TECHNICAL REPORT

Title: Parallel resonance

This report contains information gathered with the demonstrator board on parallel resonant circuits.

Having the capacitor branch out of the circuit both lamps, #1 & #3, light with the same intensity. Since the circuit is a series inductive-resistive circuit the current through all components is the same.

When 4.5 mfd, were connected in parallel with the inductance, lamp #1 becomes dimmer, indicating less line current. Lamp #2 in capacitor branch is dimmer than lamp #3 in inductor branch. This indicates that the circuit is inductive since the Xc is greater than the Xl and the inductive branch current is greater than the capacitive branch current.

When the capacitance was increased to 5.5 mfd. the circuit aproached resonance condition. Lamp #1 intensity dropped again, indicating a decrease on line current. No apreciable change was noted on lamp #3 in the inductive branch, while lamp #2 in the capacitive branch increased in intensity to equal lamp #3, indicating that the tank current was equal in both branches.

If the cores of the coils were to be removed with the line voltage applied, the colis will probably burn up. Without the cores the reactance of the coils will decrease considerably, leaving as the only opposition to current the D.C. resistance of the wire plus a very small reactance.

With the circuit at the resonance condition, lamp #1 in the line remained lighted a small amaunt, because, the line current does not drop to zero since the tank circuit must be supply with energy from the line to keep going.

Voltages readings taken in all three steps.

#1 Lamp #1------- 3.4 volts
 " #3------- 3.45 volts
 Across the coils ----- 106 volts

#2 Lamp #1 ------1.8 volts
 " #2 ------2.5 "
 " #3 ------4 "
 Across the inductor----110 volts
 " " Capacitor---114 "

#3 Lamp #1------1.6 volts
 " #2------3.5 "
 " #3------3.5 "
 Across the inductor----111 volts
 " " capacitor---112.5 volts

Los Angeles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

JS--
Agustin lucas
April 16 1957

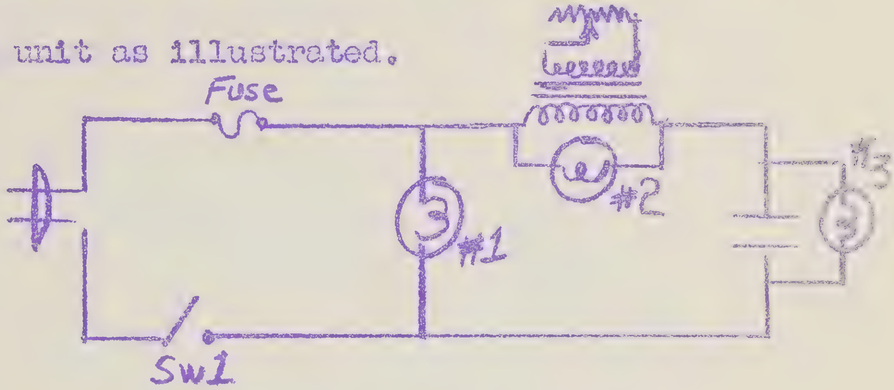
ELECTRONICS TECHNICIAN

JOB SHEET

Loading the Resonate Circuit

Objective: to note the effects of loading by removing power from a series resonate circuit.

Materials & Equipment: Prepared unit as illustrated.



Procedure: Answer questions and give results on a technical report form.

1. Disconnect one lead to the resistor for a no load condition. Closesw#1 and observe the rise of voltage as the circuit nears resonance.

2. Open sw#1 and connect the 25 ohm resistor to the secondary. Explain why the intensity of the lamps are different.

3. Slide arm of resistor to maximum position. Lift arm without moving to a new position. Note result and explain.

4. Increase the load upon the secondary to 5 ohms. Explain the difference of intensity between the lamps.

5. Short out the secondary. Observe the intensity of lamps #2 and #3. Give your explamation of the results

Agustin Lucas
April 16 1957

TECHNICAL REPORT

LOADING OF THE RESONANT CIRCUIT

This report contains information gathered with the demonstrator board.

With the load disconnected, lamp #3 across the capacitor was brighter than lamp #2 across the transformer with both being brighter than lamp #1 across the line. Since the circuit is a series cicuit the lamps indicate that the Xc is greater than the Xl and that the voltages drops across the reactances were greater than the line voltage.
Actual voltage readings:
Line-------120 Xc------200 X_L-------150

As the secondary of the transformer was loaded with 25 ohms, both lamps decreased in intensity, lamp #2 being slightly brighter. By connecting a resistive load in the secondary the total impedance of the primary is increased. The secondary current sets up a magnetic field which opposes the the field set up by the primary and the net effect is a reflected resistance back to the primary which is equal to the load resistance times the square of the turns ratio of the transformer. This increase in impedance in the circuit decreases the current flowing, therefore there is a decrease on the voltage drop across the reactance.
Actual voltage readings:
Xc------147 X_L------183
With maximum resistance of 25 ohms in the load, lamp #2 has slightly more intensity than lamp #3 showing a larger IR drop across the transformer due to the reflected impedance.
When the load is disconnected the circuit returns to the original position both lamps being cosiderably brighter. (* Note)

By increasing the load in the secondary, the reflected impedance is decreased, the total impedance of the circuit is decreased and the current increased. Therefore since the impedance of the transformer decreased lamp #2 dims,showing a decrease in the IR drop. Lamp #3 incresed in intensity, showing an increse in the current in the circuit and a greater IR drop across the capacitor.
Actual voltage readings:
Xc------112 X_L-------78

With the secondary shorted out, lamp #2 is out. This indicates that the IR drop across the transformer is very low. The strong magnetic field set up by the secondary current cancels much of the magnetic field set up by the primary, decreasing the reactance considerably, increasing the current in the circuit. Therefore lamp #3 shows more intensity.
Actual voltage readings:
Xc-----123 X_L------7

*- SATURATION OF THE CORE.

Los Angeles Trade Tech. Jr. College
Instructor: R. H. Oeffinger

ELECTRONICS TECHNICIAN

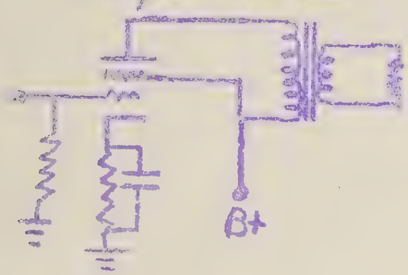
JOB SHEET

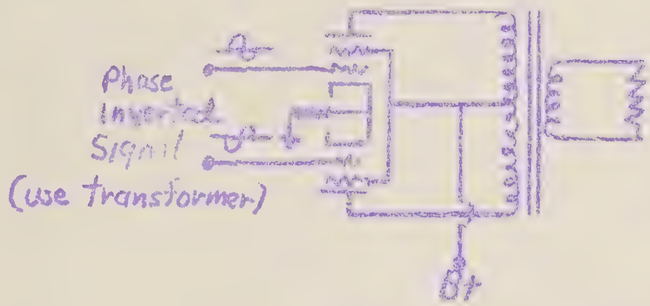
Power Amplifiers-Audio

Objective: How to construct and test audio power amplifiers.

Materials: Components and parts to build the following circuits:

Single-Ended





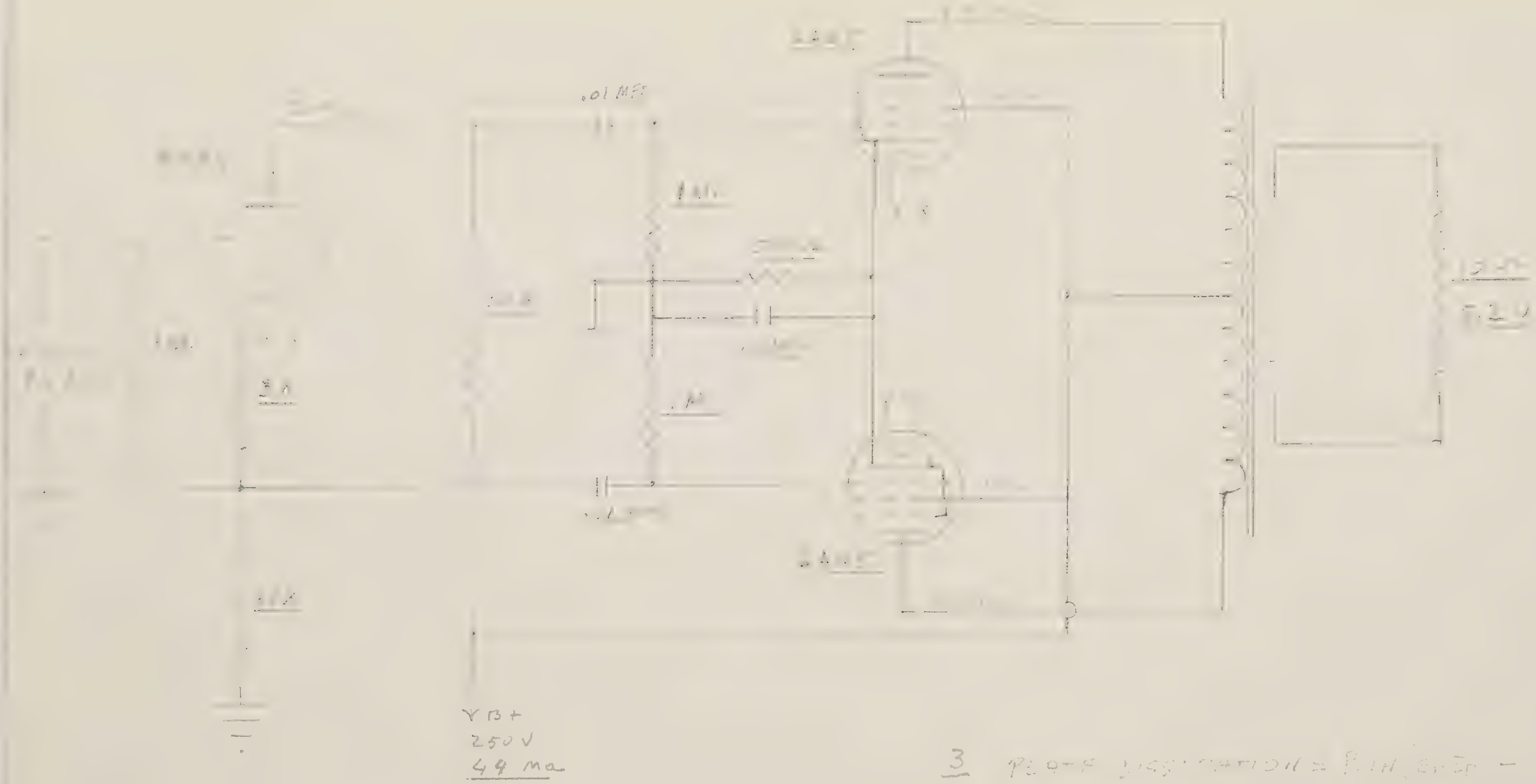
Push-Pull

Equipment: Audio generator, oscilloscope, AC voltmeter, and load resistors.

Procedure: Use tube manual to determine value of components.

Construct first the single-ended amplifier.
Determine the following for the amplifier:
1. Max. undistorted output and required input signal.
   Power sensitivity
2. Plate dissipation
3. Plate efficiency
4. Db. Gain

Construct the push pull amplifier
Repeat 1, 2, 3, & 4.



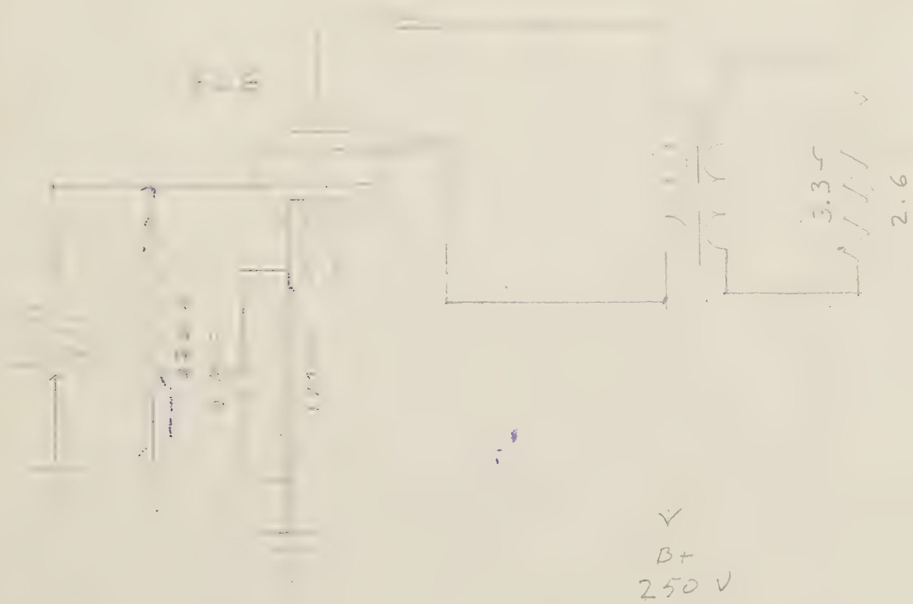
3 PLATE DISSIPATION = P IN ... − P OUT =
250 X .04 = 10 10 − 2.7 = 7.3 WATTS

4 PLATE EFFICIENCY = $\frac{P\ OUT}{P\ IN}$ X 100 = $\frac{2.7}{10}$ X 100 =

1 ... OUTPUT 5.2 V RMS
... INPUT ... 9.5 V ...

. POWER SENSITIVITY = $\frac{P.\ OUT}{Eg^2}$ X 10^6 MHOS

School: Los Angeles Trade Tech J.C.	Title:	Date
Los Angeles, California	Drawn By:	
Class : Electronics	Approved By:	



SINGLE ENDED POWER [illegible]

1. MAXIMUM UNDISTORTED OUTPUT = 2.6 V RMS

[illegible]

2. POWER SENSITIVITY = $\frac{P.\,OUT}{E_g^2} \times 10^6$ MHMOS =

$P.\,OUT = \frac{E^2}{R} = \frac{[illegible]}{3.3} =$ 2.[illegible] WATTS

E_g^2 — [illegible]

3. PLATE DISSIPATION = $P.IN(E_p I_p) - P.OUT$ =

$= 250 \times .071 - 2.3 =$ 15.4 WATTS

4. PLATE EFFICIENCY = $\frac{P.\,OUT}{P.IN(E_p I_p)} \times 100$ =

$= \frac{2.3}{17.7} \times 100 =$ 13 %

5. DB. GAIN = $Ndb = 10 \log \frac{P.\,OUT}{P.\,IN\left(\frac{E_g^2}{R_g}\right)}$

$= 10 \log \frac{2.3}{2.23 \times 10^{-4}} = 4. \times 10 =$ 40 DB

Los Angeles Trade-Tech. Jr. College	Title: [illegible]	Date.
Los Angeles, Calif.	Drawn by: [illegible]	[illegible]
Electronics	Approved by:	

Agustin Lucas
March 27 1957
JS-

Los Angles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

ELECTRONICS TECHNICIAN

JOB SHEET

Reactance Measurements

Objective: How to determine values of unknown components.

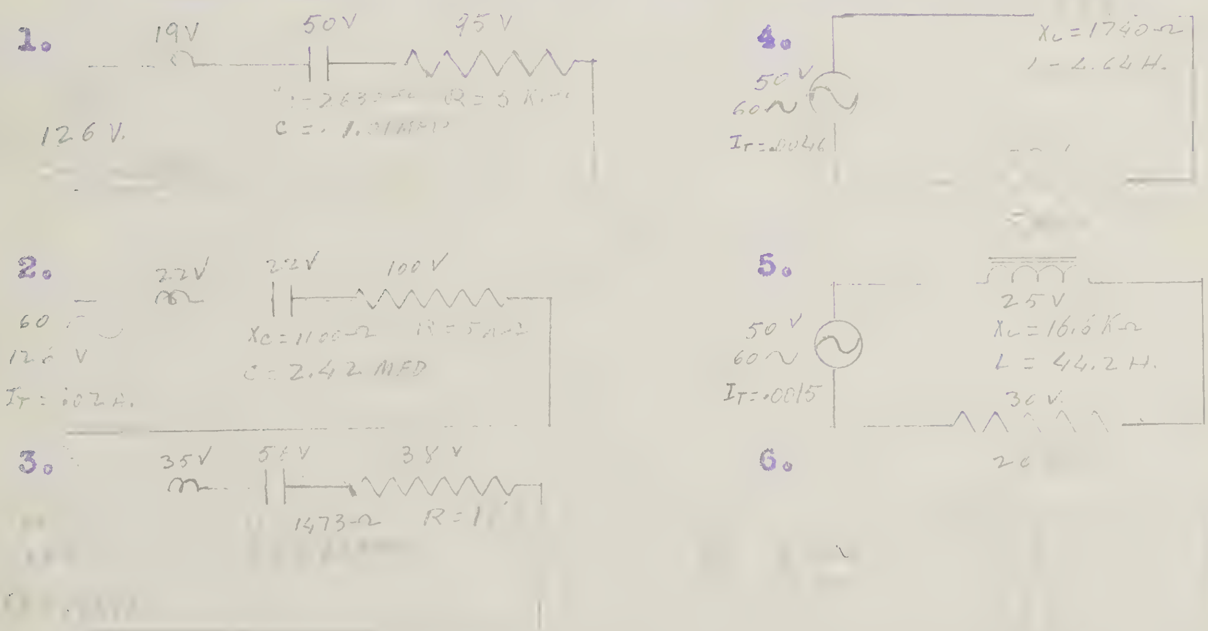
Materials; $7\frac{1}{2}$ watt lamp and various sizes of resistors, capacitors and inductances as needed.

Equipment: AC voltmeter and the 6 boxes with concealed components.

Procedure: Determine what component is in each box, giving its value in ohms, inductance or reactance.

Use the 60 cycle source as the AC EMF. CAUTION--have lamp in series with line source.

Draw schematic of method and components used for solving each one.



Method used: First it was determined which box contained a capacitor by checking with the ohm-meter. Then each individual box was connected to a signal generator with an output of 50 volts, observing the voltages drops across each element as the fr. was varied. Once it was determined what was in the box, the values of each component were found by using ohms law and the formulas for reactances, after they were connected to the 60 cycle A.C. line in the manner shown.

Agustin Lucas
March 26 1957

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ELECTRONICS TECHNICIAN

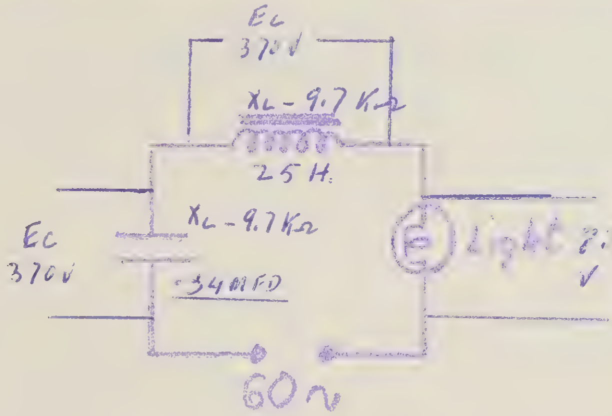
JOB SHEET

Resonance

Objective: How to construct a circuit with inductive and capacitive reactive components equal and to study the effects of resonance.

Materials: .5 mfd and .01 mfd capacitors.

Equipment: Series resonance board (as illustrated) and AC voltmeter



Procedure: Connect circuit to 60 cycle source and record the following:

Short out one at a time the capacitance and inductance and make a note on the intensity of the light; measure voltage across the inductance and capacitance; place in parallel one at a time first the .5 mfd and then the .01 mfd capacitor with the existing capacitance, recording both the voltages existing across the reactances and the intensity of the light

Summary Questions:

1. What happened to the light when shorting out either the capacitor or inductance?

   When one of the reactive components was shorted out, the light dimmed considerably. This effect was caused by the increase of reactance as the circuit went off resonance, decreasing the current flow.

2. At Resonance what should the voltage drops be across the reactances? Explain.

Resonance (cont.)

Summary Questions (cont.)

2. (cont.) The voltage drops across the reactances should be equal since the value of both reactances is the same and the current being equal in all the parts of the circuit.

$$X_L = X_c$$

3. When resonance occurs what limits the flow of current? What is "Q"?

At resonance both reactances are equal and opposite, so they effectibly cancel out, leaving the resistance of the circuit as the only opposition to current.
Q is the merit of the circuit. (How selective). Also it is an indication of how much resistance is in the circuit.

$$Q = \frac{X_L \text{ or } X_c}{R}.$$

4. In each case what happened to the light and the voltages across the reactances when the capacitors where paralled? Give your own explanation.

When the .5 Mfd. capacitor was placed in paralell with the capacitor in the circuit the ligth went out. The voltage across the capacitor dropped by 300 volts, while the voltage across the inductance dropped by 200 volts. As the capacitance was increased, the Xc was decreased, making the X_L more predominant. The circuit is no more at resonance. The current was decreased as the total impedance was increased. Paralelling the .01 Mfd. had hardly no effect since the original capacitance of .34 Mfd is quite large compared with .01 Mfd.

5. What is the formula for the resonant frequency? What does a series circuit represent above and below resonance? Explain.

$$F_o = \frac{1}{2\pi\sqrt{LC}}$$

A series circuit, above resonance acts inductive or represents an inductor. An increas in frequency will make the X_L more predominant.
Below resonance the circuit acts capacitive, since a capacitor presents more reactance to the lower frequency.

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March 26 1957

Los Angeles Trade Tech. Jr. College
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ELECTRONICS TECHNICIAN

JOB SHEET

<u>Transformer Characteristics</u>

Objective: How to measure the characteristics of transformers.

Materials: Power transformer with all windings removed except primary, 5 ohm 20 watt or more resistor, 5 ohm 10 watt resistor, #30 and #20 enamel covered wire, and insulating tape.

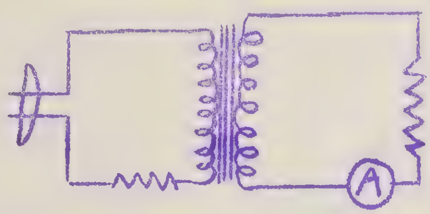
Equipment: Voltmeter and ~~low range AC ammeter~~.

Procedure: I. On top of primary wind ~~20~~ 80 turns of #30 wire.
Measure voltage across primary and secondary.
How many turns are in the primary? 760

II. Connect equipment as shown:

$E_p = 114$ v.
$E_s \ \ 12$ v.

$\frac{N_p}{N_s} = \frac{E_p}{E_s} \therefore \frac{N_p}{80} = \frac{114}{12}$ $N_p = 760$ turns



Measure voltage across load resistor and series resistor in the primary. Record reading of ammeter in the secondary.

From data recorded to this point, solve the following:

a. Turns ratio. $\frac{760}{80} = \frac{9.5}{1}$ Step down.

b. Wattage in primary and secondary.

c. % of efficiency.

III. Wind ~~20~~ 80 turns on top of last winding with ~~#20~~ #21 wire.
Measure resistance of both secondary windings. #1 = 6 Ω #2 = .8 Ω

Repeat all instructions and steps as in II.

Secondary with #30 wire:

Ep----- 100 volts.

Es-----4.7 volts.

Voltage across 5 ohms resistor in primary----1.8 volts.

Ip----- $\frac{1.8}{5}$ = .36 amps.

Is---- $\frac{4.7}{5}$ = .94 amps

Primary watts----- 100 x .36 = 36 w.

Secondary watts---- 4.7 x .94 = 4.42 w.

Efficiency----- $\frac{4.42}{36}$ = 12.3 %

Secondary with #21 wire:

Ep----- 96 volts.

Es------8.6 volts.

Voltage across 5 ohms resistor in primary---1.6 volts.

Ip---- $\frac{1.6}{5}$ = .32 amps.

Is----$\frac{8.6}{5}$ = 1.72 amps.

Primary watts---- 96 x .32 = 30.72 W.

Secondary watts----8.6 x 1.72 = 14.8 W.

Efficiency---- $\frac{14.8}{30.72}$ = 48.2 %

Summary Questions:

1. Give your reason for the difference of potential found across the load resistor in the two secondary windings:
   Since the size of the conductor is one of the factors that determine the amount of EMF induced in a coil, the amount of induced EMF in the #21 wire coil was therefore greater.

2. Why is it impossible to reach 100% efficiency?

   To reach 100% efficiency, the phase angle between the voltage and the current must be zero. A point impossible to reach since all the inductive effect can not be eliminated. Also there is a certain amount of flux leakage and core losses.

3. From the wire table calculate how many feet in each secondary winding, and the circular mills of each size of wire

   #30 wire--------100 circular mils.
   #30wire---------105 ohms per 1000 feet.

   $\frac{105}{1000} = .105$ ohms per foot.
   #30 coil = 6 ohms D.C. resistance.

   $\frac{6}{.105} = 57.14$ Feet in coil

   #21 wire---------810 circular mils.
   #21 wire---------13.1 ohms per 1000 feet.

   $\frac{13.1}{1000} = .0131$ ohms per foot.
   #21 coil = .8 ohms D.C. resistance.

   $\frac{.8}{.0131} = 61$ Feet in coil.

Operation used
APRIL - 3 - 57

Los Angeles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

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ELECTRONICS TECHNICIAN

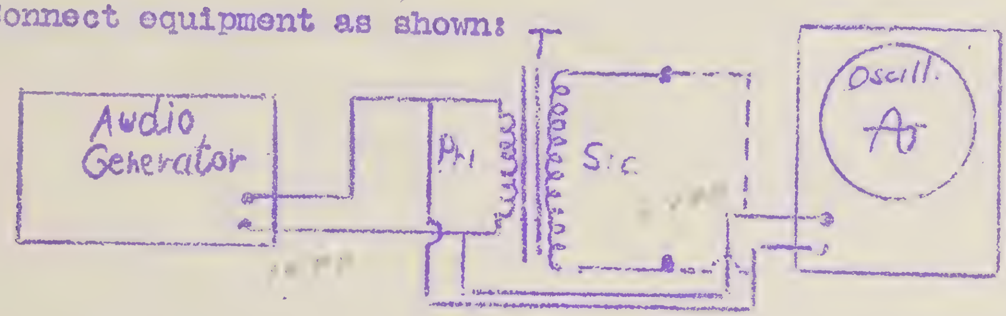
JOB SHEET

Transformer Impedances

Objective: How to measure the impednce of a transformer winding.

Equipment: Audio output or interstage transformer, oscilloscope, and audio generator.

Procedure: Connect equipment as shown:



Set audio generator frequency at appx. 1000 cycles. Increase output from generator until a readable waveform is present on the oscilloscope at the output terminals of the generator. With the oscilloscope measure the voltage on the secondary of the transformer.

Use the voltage readings of the primary and secondary to determine the impedance of the two windings.

SHOW ALL WORK OR STEPS HERE:

TRANSFORMER USED - STANCOR - A-3956 OUTPUT

INPUT VOLTAGE 30 V P.P.

OUTPUT " 3 " "

RATIO : $\frac{E_P}{E_S} = \frac{N_P}{N_S} = \frac{30}{3} = 10$

SECONDARY IMPEDANCE = 61 Ω

IMPEDANCE RATIO: $\frac{Z_P}{Z_S} = \left(\frac{N_P}{N_S}\right)^2 = \left(\frac{N_P}{N_S}\right)^2 = 10^2 = 100$

$Z_P = Z_S\left(\frac{N_P}{N_S}\right)^2$

$\frac{Z_P}{61} = 100$ $Z_P = 61 \times 100 = 6100\ \Omega$

Los Angeles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

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Agustin Lucas
April 15 1957

ELECTRONICS TECHNICIAN

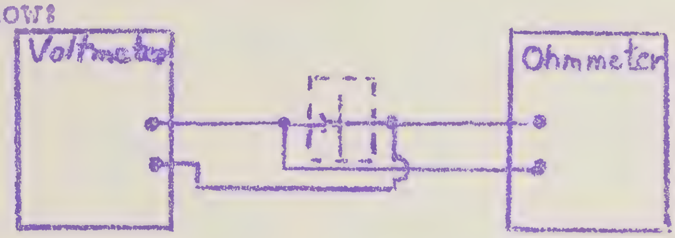
JOB SHEET

Germanium Diode Characteristics

Objective: To study the forward and reverse characteristics of germanium diodes with respect to voltage, current, and temperature.

Materials: Seven diodes mounted on board.

Equipment: As shown below:



Procedure: Check each diode as follows:
Set one VTVM on the 1½ volt scale and connect across the diode. Place the function swithh on ohms for the other meter and also place across the diode.

Check voltage from ohmmeter for forward conduction. Start with X1 range reading both the resistance and voltage. From this calculate the current. Repeat with the balance of the resistance ranges.

Connect ohmmeter for the reverse polarity and repeat all steps as in the forward conduction.

Record all information as in the example below:

	FORWARD			REVERSE		
Type	Resistance	Voltage	Current	Resistance	Voltage	Current
1N34	500 ohms	1.44	2.88ma	Inf.	1.5	0
	600 ohms	1.28	2.13	Inf.	1.5	0
	1.18K	.82	.697	Inf.	1.5	0
	2.8K	.33	.118	1 Meg	1.48	1.480ua
	8.0K	.11	.01375	1.1 Meg	1.37	1.245
	20K	.03	.0015	.54 Meg	.54	1.00
	----	0	----	10K	.02	2.00

Summary Questions

1. Which diode was defective? Give your reasons according to readings taken.

2. For the reverse condition, why does the resistance increase with an increase in applied voltage?

3. In the forward condition, why does the resistance decrease with an increase in applied voltage?

GERMANIUM DIODE READINGS

FORWARD			REVERSE		
Resistance	Voltage	Current	Resistance	Voltage	Current
		1N48			
150 ohms	1.43 volts	9.54 ma.	Inf.	1.54	---
210 "	1.03 "	4.92 "	"	1.54	---
470 "	.47 "	1. "	"	1.54	----
1.5 K	.18 "	,12 "	500 K	1.5	3 ua.
6 K	.065 "	.108 "	310 K	1.16	3.74 ua.
10 K	.005 "	.5 ua.	20 K	.04	2. ua.
0	0	0	0	0	0
		1N51			
220 ohms	1.48	6.74 ma.	Inf.	1.55	-------
290 "	1.13	3.9 "	"	1,55	-------
500 "	.52	1.04 "	20 K	1.46	73 ua.
1.5 K	.19	.169 "	16 K	.98	61.5 ua.
5 K	.06	.012 "	14 K	.18	18.5 ua.
8 K	.006	.75 ua	10 K	.04	4. ua.
0	0	0	0	0	0
		1N52			
110 ohms	1.4	12.8 ma.	Inf.	1.54	-------
170 "	.94	5.52 "	"	1.54	-------
420 "	.43	1.025 "	"	1.54	-------
1.6 K	.19	.1088 "	200 K	1.47	7.35 ua.
6K	.07	.01168 "	160 K	.94	5.87 "
0	0	0	30 K	.04	4. "
0	0	0	0	0	0
		1N60			
90 ohms	1.38	15.35 ma.	Inf.	1.54	-------
130 "	.86	6.62 "	"	1.54	-------
320 "	.36	1.125 "	"	1.54	-------
1.23 K	.16	.15 "	175 K	1.48	8.45 ua.
5.9 K	.07	.1189 "	150 K	.92	6.14 "
8 K	.015	.00175 "	40 K	.05	1.25 "
0	0	0	0	0	0
		1N65			
110 ohms	1.41	12.8 ma.	Inf.	1.55	--------
151 "	.92	6.09 "	"	1.55	--------
360 "	.39	1.075 "	"	1.75	--------
1.32 K	.17	.129 "	500 K	1.52	3.2 ua.
6 K	.08	.0133 "	275 K	1.13	4.11 "
19 K	.02	1.05 ua.	90 K	.12	1.33 "
0	0	0	10 K	.005	.5 "
		CK707			
98 ohms	1.4	14.3 ma.	Inf.	1.55	--------
140 "	.89	6.35 "	"	1.55	--------
340 "	.38	1.12 "	"	1.55	--------
1.2 K	.15	.125 "	500 K	1.54	3.4 ua.
4.8 K	.06	.0125 "	440 K	1.25	2.74 "
10 K	.01	1. ua.	44 K	.06	1.363 "
0	0	0	0	0	0

SUMMARY QUESTIONS ON DIODE JOB SHEET:

#1. By comparing the readings of all diodes, there seems to be an indication that diode 1N51 may be defective. The current on the reverse direction is extremely high compared with the other diodes readings and the reverse resistance many times lower. These facts would indicate that this particular diode will not be to effective as a rectifier.

#2 In the reverse condition, the diode is biased with a positive potential on the N material and a negative potential on the P material, exerting an atraction on the electrons and holes away from the junction towards the terminals. Increasing the potential between the terminals, will increase the atraction, which in effect is like incresing the resistance of the junction to current flow.

#3 In the foward condition, the diode is biased with a negative potential on the N material and a positive potential on the P material, with the effect of a driving force pushing the electrones and holes towards the junction where they combine. Increasing the voltage at the terminals increases the driving force, which moves more electrons and holes. The net effect is like decreasing the resistance of the junction to the carriers, since the combination of holes and electrons constitutes the current flow.

Agustin Lucas
May 8 1957
JS--

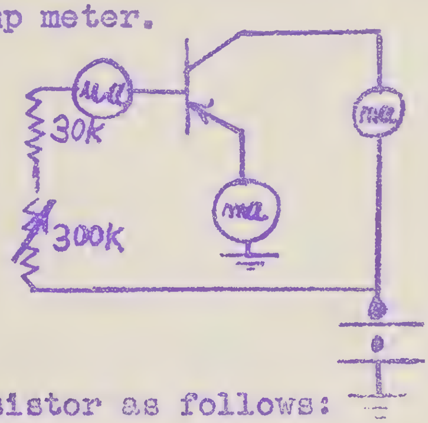
Los Angeles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

ELECTRONICS TECHNICIAN

JOB SHEET

Transistor Characteristics

Objective: To observe the effect of a change in emitter and base current on output or collector current.
Materials: Prepared transistor circuit and two different types of PNP junction transistors.
Equipment: Two 10 ma meters and a microamp meter.
Procedure: Connect equipment as shown:



Plot two curves for each transistor as follows:

A. Y axis= Collector Current.
   X axis= Emitter Current.

B. Y axis= Collector Current.
   X axis= Base Current.

Summary Questions:

1. What is Beta?---What value from the curves plotted was the value of beta for each transistor?

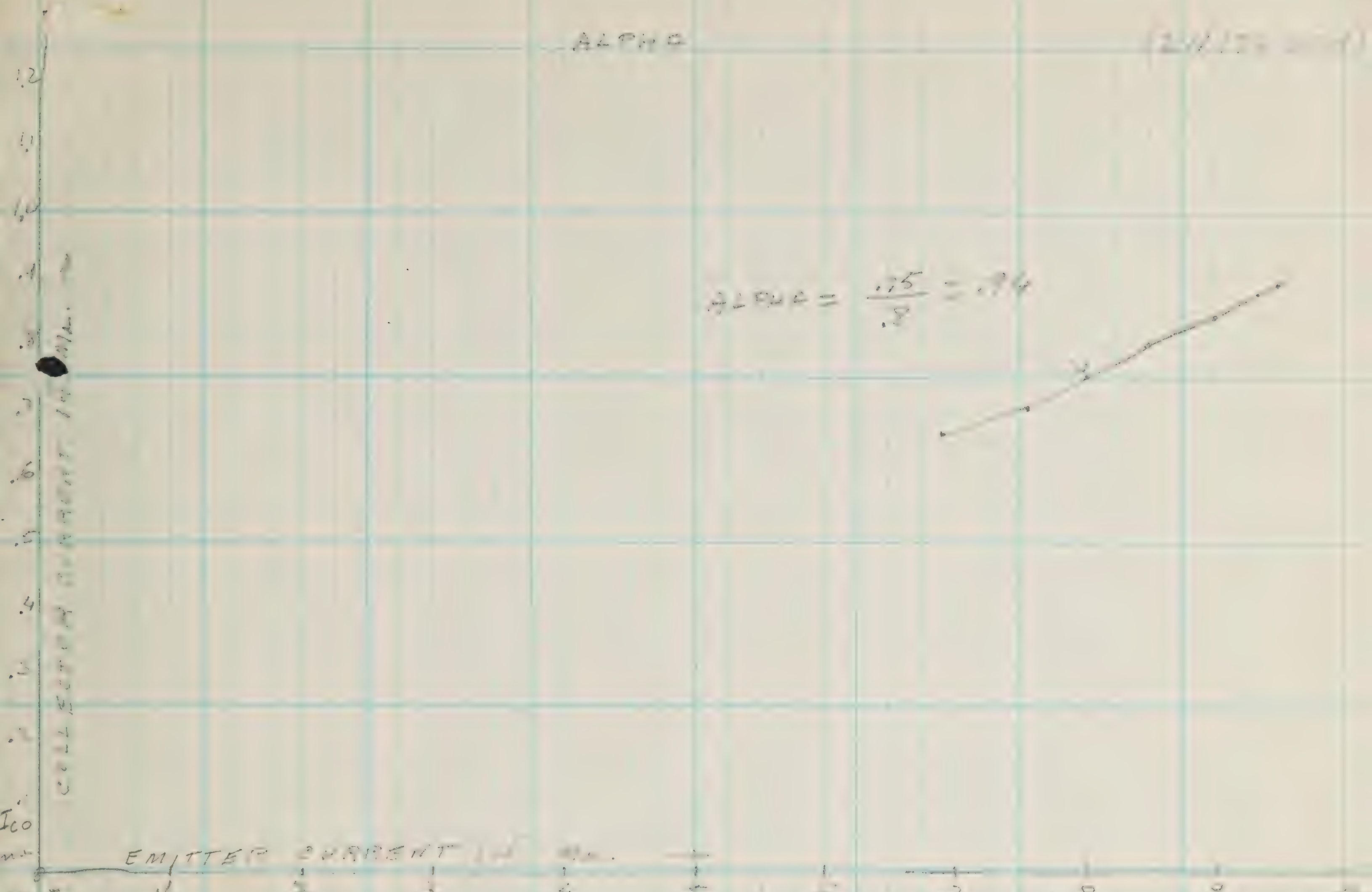
2. What is Alpha?--Using the curves what was the value of alpha for each transistor?

1. Beta is the ratio of collector current to base current, used only on the grounded emitter transistor circuit.

   Beta of 2N170 ----18.75
   " " 2N229-----30

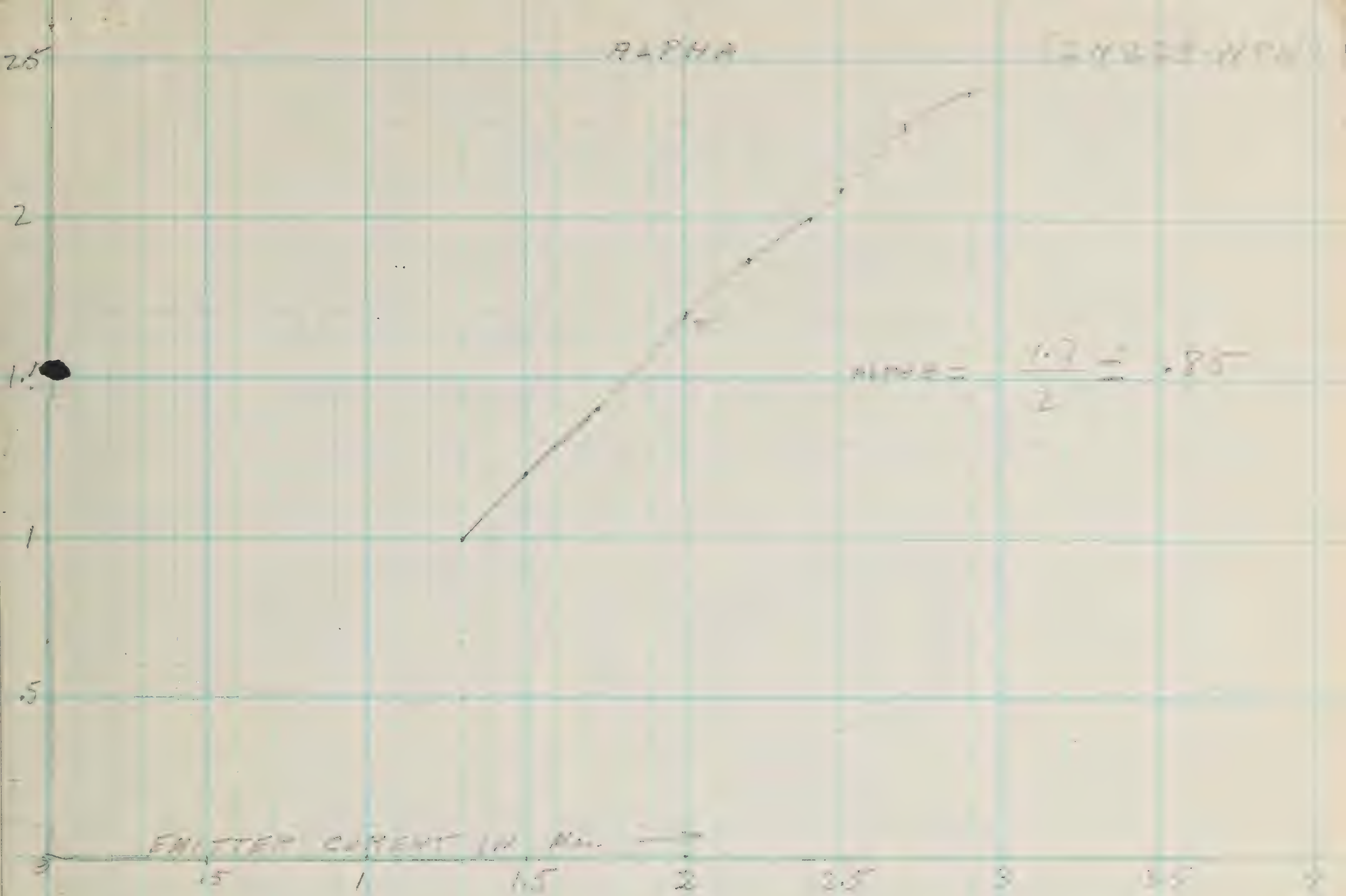
2. Alpha is the ratio of collector to emitter current.

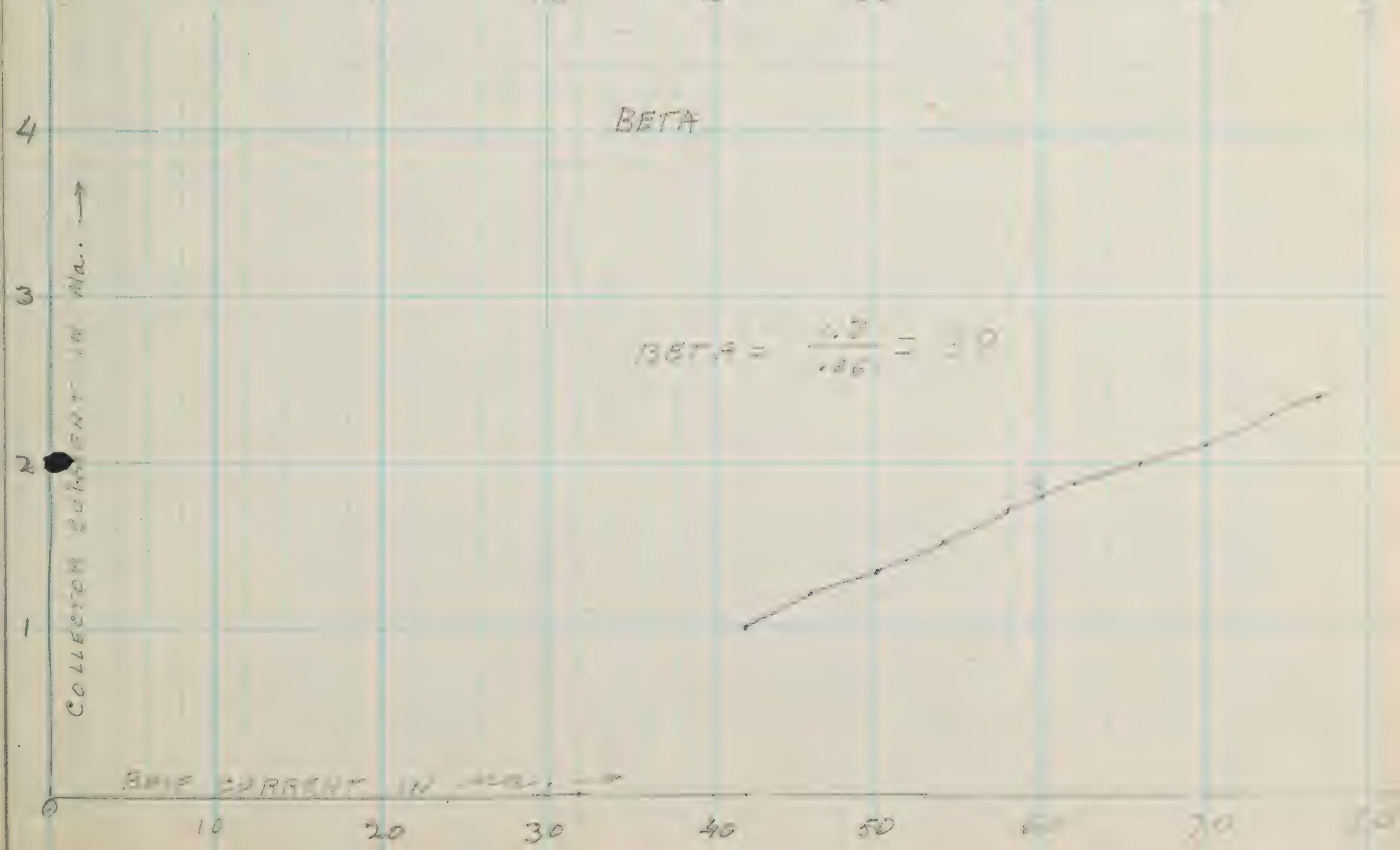
   Alpha of 2N170 ----.94
   " " 2N229 ----.85



ALPHA
ALPHA = .75/.8 = .94
COLLECTOR CURRENT IN MA.
EMITTER CURRENT IN MA.
I_{CO}
I_E

BETA
BETA = = 18.75
COLLECTOR CURRENT IN MA.
BASE CURRENT IN UA.


ALPHA
2.5
2
1.5
1
.5
EMITTER CURENT IN MA.
.5
1
1.5
2
2.5
3
3.5


BETA
4
3
2
1
COLLECTOR CURRENT IN MA.
10
20
30
40
50
70

Los Angeles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

JS--

Agustin Lucas
May 8 1957

ELECTRONICS TECHNICIAN

JOB SHEET

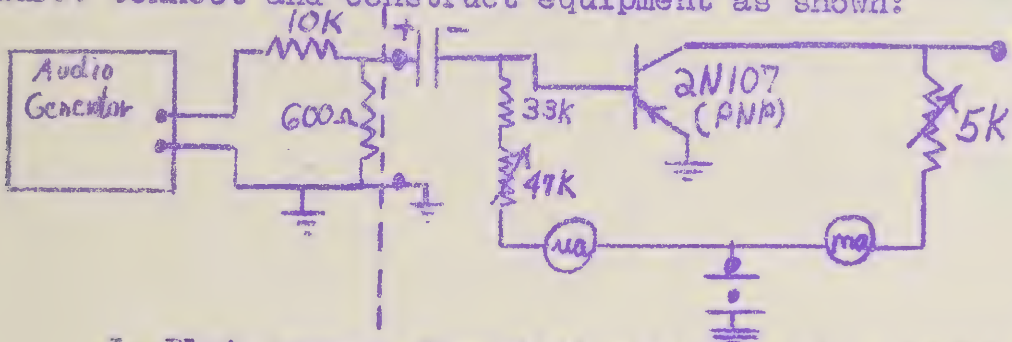
Transistor Amplifier Characteristics

Objective: To determine the amplifying characteristics of a typical transistor amplifier.

Materials: Prepared transistor circuit board and components as illustrated.

Equipment: Oscilloscope, microammeter, ma. meter, and an audio signal generator.

Procedure: Connect and construct equipment as shown:



I. Plot curves of variation in I_c with a change in I_b for two collector loads--1K and 2K.

II. From reference data determine the input impedance of this transistor. With this information and the curves plotted determine the current and voltage gain for each load.
SHOW ALL WORK

Input impedance: 700 ohms. Voltage gain: $\frac{\Delta Ec}{\Delta Eb}$ Current gain: $\frac{\Delta Ic}{\Delta Ib}$

1 K. Load: Current gain: $\frac{.2 \text{ ma.}}{10 \text{ ua.}} = 20$

Δ Ec = .0002x1000 = .2 volts
Δ Eb = 10ua. x 700 = .007 volts

Voltage gain: $\frac{.2}{.007} = 28.57$

2 K. Load: Current gain: $\frac{.2 \text{ ma.}}{10\text{ua.}} = 20$

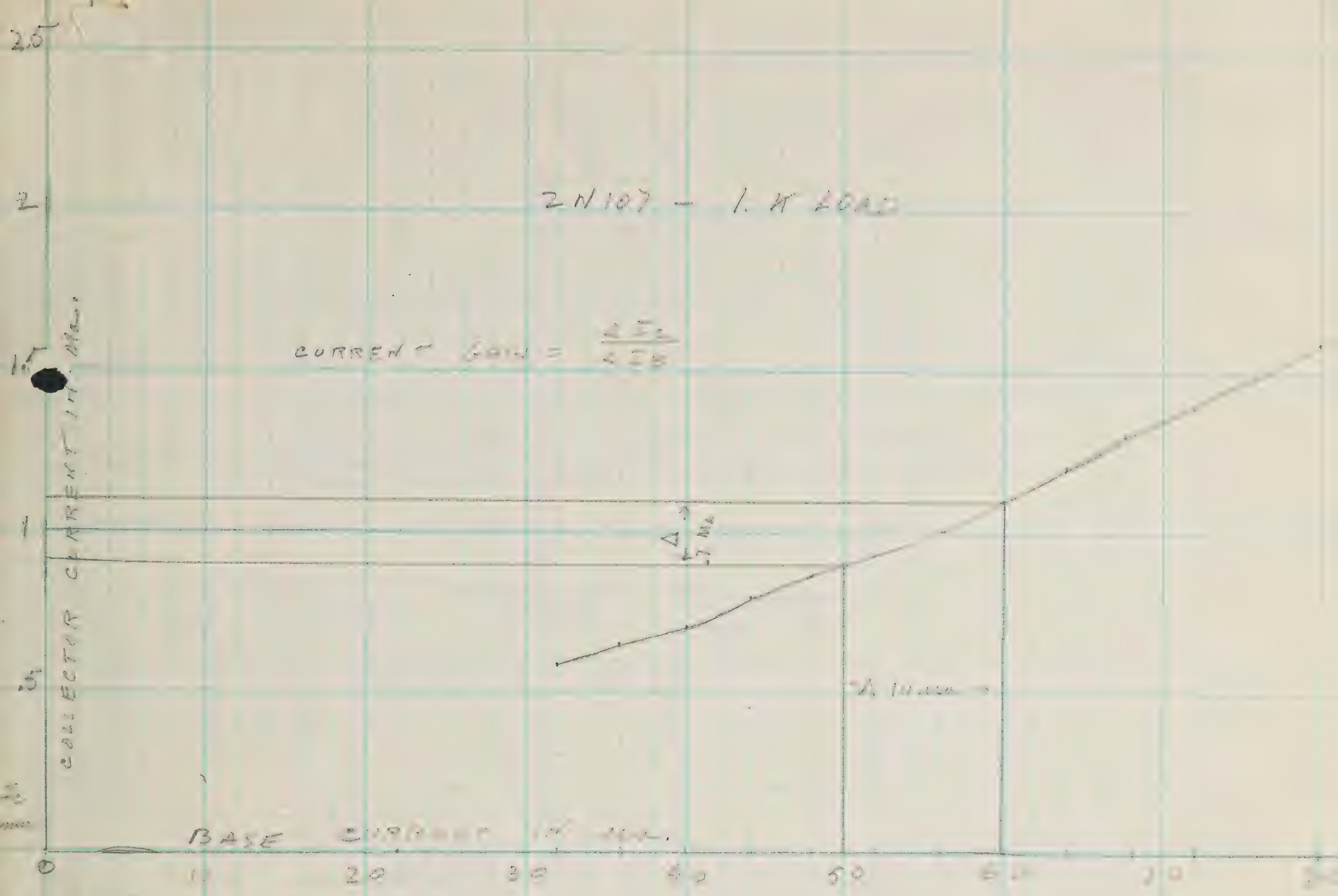
Δ Ec = .0002x2000 = .4 volts
Δ Eb = 10ua x 700 = .007 volts

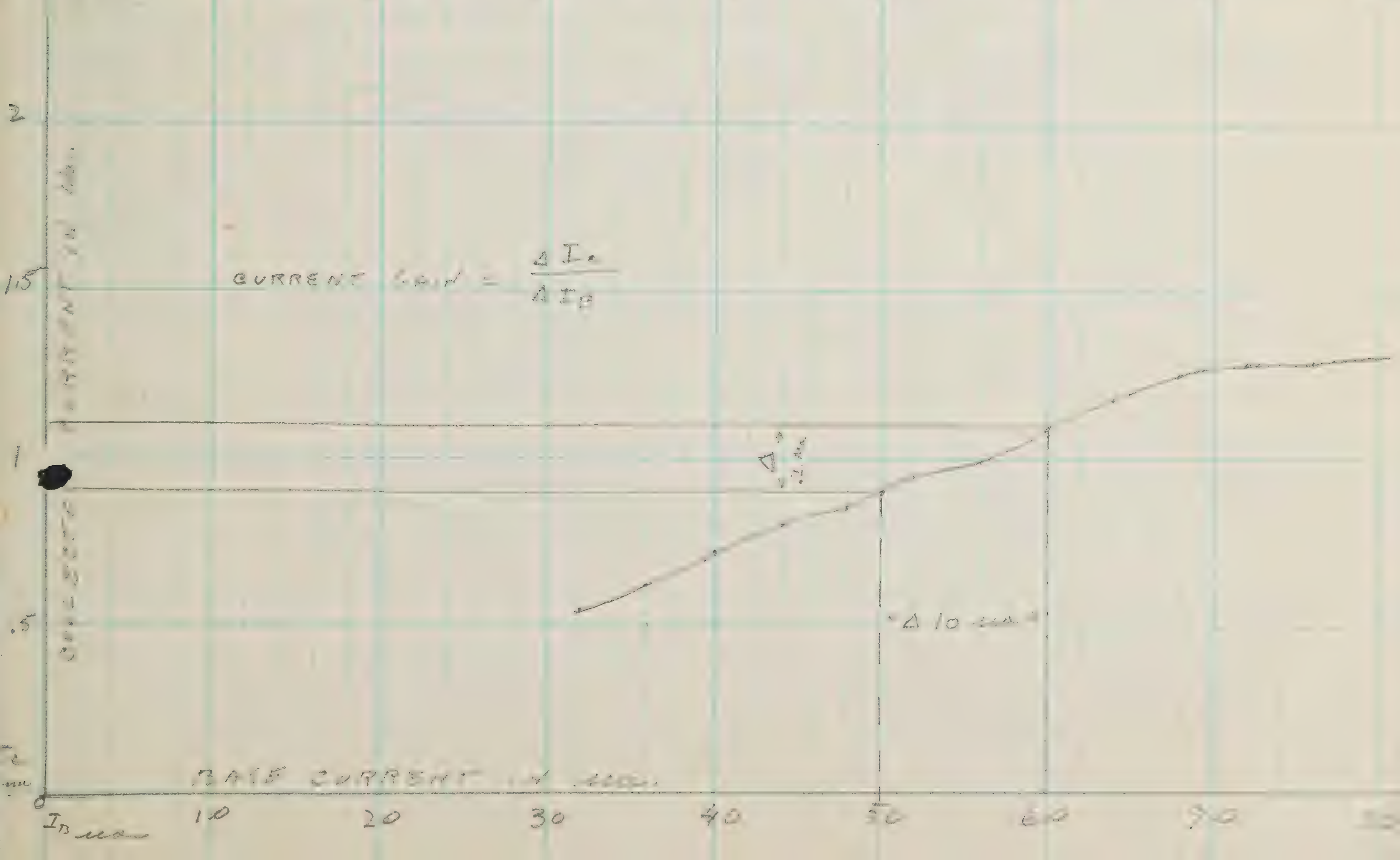
Voltage gain: $\frac{.4}{.007} = 57.14$

III. Connect audio generator in series with the 10k ohm resistor and oscilloscope on output of amplifier. Adjust output of generator and bias for maximum undistorted output. Measure with oscilloscope input and output voltages. Compare this voltage gain with the calculated values in step # 2.

1 K. Load: Input------.085 volts. Output--- 1.7 volts. Voltage gain 21.2

2 K. Load: Input-----.04 volts. Output----1.4 volts. Voltage gain 35


2N107 — 1 K LOAD
CURRENT GAIN = $\frac{\Delta I_C}{\Delta I_B}$
COLLECTOR CURRENT IN MA.
BASE CURRENT IN μA.


CURRENT GAIN = $\frac{\Delta I_C}{\Delta I_B}$
Δ 10 μA
BASE CURRENT IN μA.

Los Angeles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

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Agustin Lucas
May 10 1957

ELECTRONICS TECHNICIAN

JOB SHEET

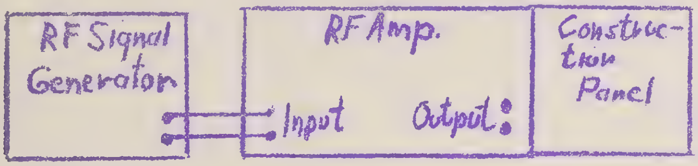
Demodulation

Objective: To observe the characteristics of detectors and understand the principles of demodulation.

Materials:. Crystal diode, 6C5 tube, and various resistors and capacitors as required to construct detectors.

Equipment: 455Kc RF amplifier, signal generator(RF with AM modulation), oscilloscope, and VTVM.

Procedure: Connect equipment as shown:



I. Connect scope across output and set signal generator frequency for maximum output. Turn function switch on generator for AM modulation. Draw waveform of modulation envelope.

II. On provided connection board of the RF amplifier, construct a crystal diode detector. Draw schematic of detector.
   a. Place scope across diode load detector.
   b. Draw waveforms for the following conditions:
      1. 100 mmfd RF by-pass.
      2. 500 mmfd " " "
      3. .01 mfd" " " .

III. Connect demodulator probe to input of scope. Observe results when placed across output of RF amplifier. What is the maximum peak to peak value of the AF component? What is the difference between a RF probe used for a VTVM and a probe for an oscilloscope? (VTVM assumed to be a DC voltmeter).

IV. Connect 6C5 as a grid leak detector. Draw schematic and show values. Compare this detector with a diode for sensitivity and ability to handle signals without distortion. Note: to operate a 6C5 as a diode, tie plate and grid together.

Los Angeles Trade Tech. Jr. College
Instructor: R. H. Oeffinger

Technician: Agustin Lucas

Date: May 10 1957

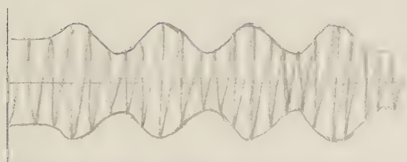
ELECTRONICS TECHNICIAN

TECHNICAL REPORT

Title: Demodulation

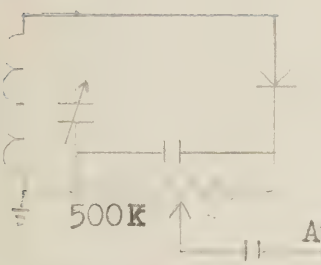
Answers to Job Sheet

I.



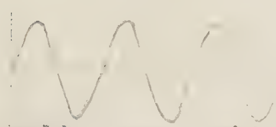
AM modulated RF carrier

II.



Diode detector

Audio wave with 100 mmfd. by-pass capacitor



Audio wave with 500 mmfd. by-pass capacitor

Audio wave with .01 mfd. by-pass capacitor

III. a. The maximum peak to peak value of the AF component obtained with the detector probe is 1.7 volts.

b. The difference between the scope and the DC VTVM RF probes is that the VTVM probe requires a filtering network so that the DC VTVM can read the voltage.

Los Angeles Trade Tech. Jr. College
Instructor: R. H. Coffinger

Student: Agustin Lucas

Date: May 10 1957

ELECTRONICS TECHNICIAN

TECHNICAL REPORT

Title: Demodulation (Cont.)

IV.

Grid Leak Detector.

Diode Detector

The grid leak detector is more sensitive. It requires less input voltage and provides amplification.

AGUSTIN LUCAS
MAY 9-57

Los Angeles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

ELECTRONICS TECHNICIAN

JOB SHEET

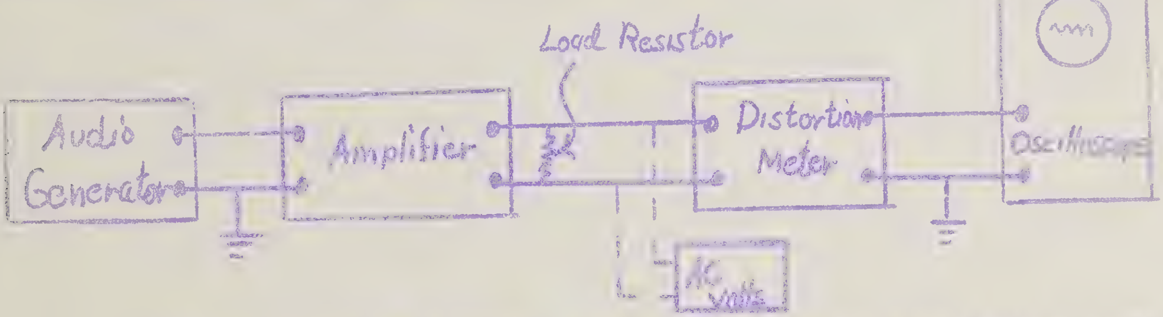
Harmonic Distortion

Objective: How to measure harmonic distortion.

Materials: Equivalent speaker load resistor.

Equipment: Audio amplifier, distortion meter, oscilloscope, audio generator, and AC voltmeter.

Procedure: Connect equipment and materials as shown:



Determine the maximum input voltage to amplifier and set output of generator for this value at 1000 cycles.

Increase volume control until rated output of amplifier is reached. This can be determined from the voltage across the load resistor--power $\frac{E^2}{R}$ watts.

Remove voltmeter and proceed with distortion check after first reading and checking with instructor on the use and ~~the~~ operation of the distortion meter.

Check and record % and type of distortion at and above and below rated output of amplifier.

At normal operation remove negative feedback and record results with respect to distortion, gain, and frequency response.

Los Angeles Trade Tech. Jr. College
Instructor: R. H. Oeffinger

TR=

Technician: Agustin Lucas

Date: May 8 1957

ELECTRONICS TECHNICIAN

TECHNICAL REPORT

Title: Harmonic Distortion

1. Maximum input voltage to the amplifier: .8 volts

2. Rated output: 6 Watts. across a 10 ohm resistor.
output voltage: 7.75 volts. $= \frac{E^2}{R} = \frac{60}{10} = 6$ Watts.

3. At rated output: 6 Watts, input---- .8 volts.
output---7.75 "
2nd. & 3rd. harmonic distortion ----- 9.3%

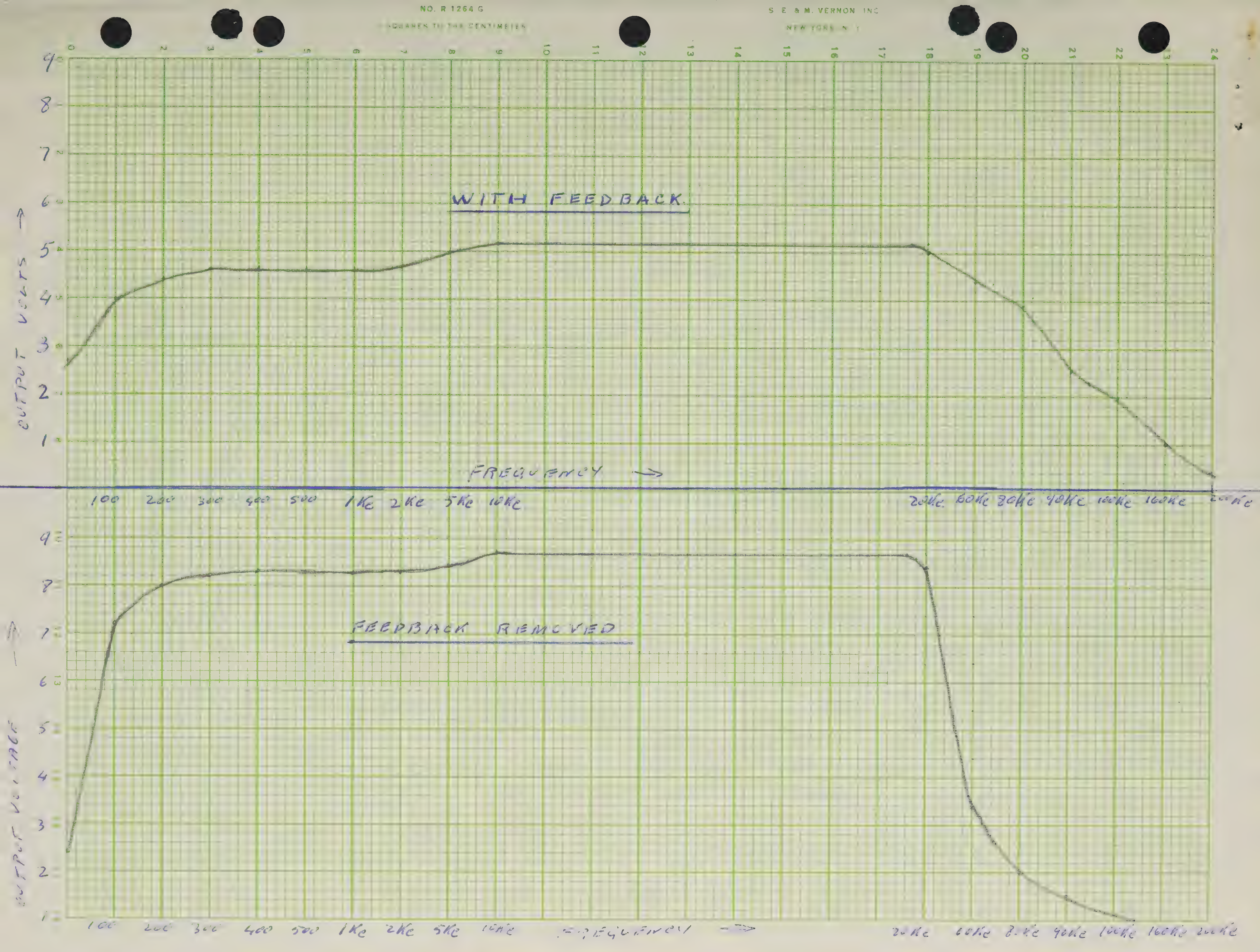
4. Below rated output: At 2 Watts, Input -------- .32 volts
Output -------4.47 "
2nd. & 3rd. harmonic distortion ------------- 2.6%

5. Above rated output: At 7.1 Watts, Input ------------ .9 volts
Output ----------8.42 "
2nd. & 3rd. harmonic distortion ------------------ 12%

6. At normal operation: 2 Watts output with feedback.
Feedback removed: Input voltage --------.32 volts
Output voltage------8 volts
2nd. & 3rd. harmonic distortion ------------12.5%
Output ----------- 6.4 Watts

Gain: $10 \text{ Log } \frac{6.4}{2} = 5.05$ Db. gain without feedback.

7. Response curves shown on separate graph.


NO. R 1264 G
SQUARES TO THE CENTIMETER
S. E. & M. VERNON INC.
NEW YORK, N. Y.
WITH FEEDBACK
OUTPUT VOLTS
FREQUENCY
100 200 300 400 500 1Kc 2Kc 5Kc 10Kc 20Kc 60Kc 80Kc 90Kc 100Kc 160Kc 200Kc
FEEDBACK REMOVED
OUTPUT VOLTAGE
FREQUENCY

AGUSTIN LUCAS
MAY - 9 - 1957

JOB SHEET

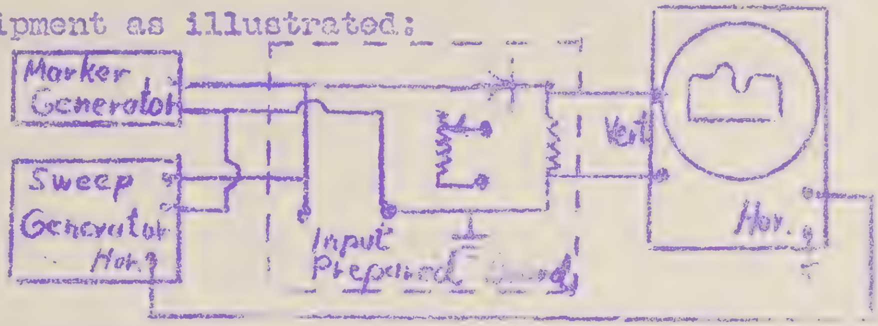
Testing Transmission Lines and Antennas

Objective: How to test and measure the characteristics of transmission lines and antennas by the sweep generator method.

Materials: Prepared materials board and 50 feet of flat antenna lead-in.

Equipment: Sweep generator, marker generator, oscilloscope, and dipole antenna.

Procedure: Connect equipment as illustrated:



I. Connect one end of the twin lead to equipment and terminate the other end with the potentiometer. Set sweep generator for maximum sweep and output.

Adjust frequency control until a maximum and minimum voltage ratio can be observed on the oscilloscope. Adjust terminating potentiometer for minimum SWR. Measure the set value and record 310 OHMS.

1. Explain why this value is the characteristic impedance of the transmission line. MINIMUM SWR. MEANS, THAT NO ENERGY IS BEING RETURNED TO THE SOURCE. ALL OF IT IS CONSUMED BY THE LOAD. THEREFORE THE LINE IS MATCHED TO THE LOAD
2. How can SWR be determined at the end of a line with the method used in theis job sheet? BY MEASURING THE MAXIMUM AND MINIMUM PEAKS OF THE SW. AND USING THE FORMULA $SWR = \frac{EMAX.}{EMIN.}$

II. Connect antenna to equipment. Vary frequency of sweep generator. From SWRs observed determine the appx. frequency at which the antenna is cut and the frequencies at which it is the most efficient. Use the marker generator to identify the frequencies. Record above results CENTER FR. 205 Mc. FR. RANGE 190 - 220 Mc.

3. Why does the antenna have more than one point of operation with respect to frequency? THE SECOND AND THIRD HARMONIC OF THE FR. FOR WHICH THE ANTENNA IS CUT CAN ALSO BE RECEIVED, BUT NOT AS EFFICIENTLY.

Los Angeles Trade Tech. Jr. College
Instructor: Bill Coffinger

Agustin Lucas
May 10 1957

ELECTRONICS TECHNICIAN

JOB SHEET

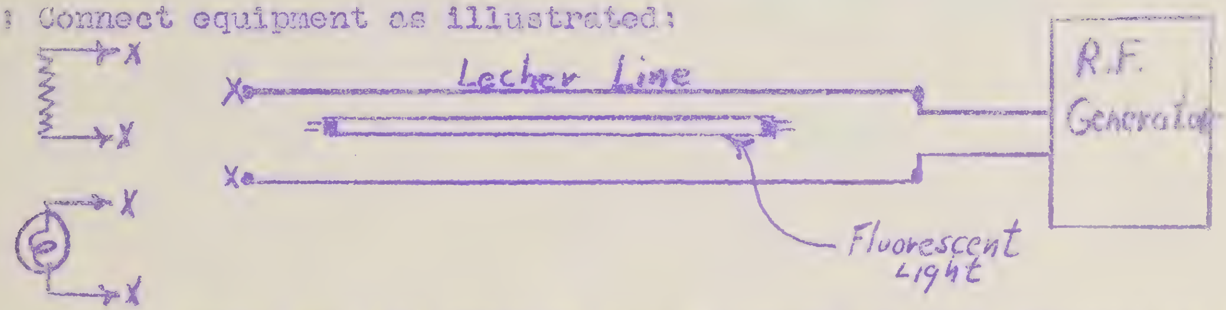
Standing-Wave Characteristics

Objective: To understand the effect of standing-waves on transmission lines.

Materials: Line terminating resistance, variable stub, neon light, fluorescent light, and incandescent lamp.

Equipment: RF power source (200-300 mc) and Lecher line.

Procedure: Connect equipment as illustrated:



I. With power applied measure the distance between centers of the dark points on the fluorescent tube with the lecher line open. Record from this the operating frequency and wavelength:

____

Move neon lamp along one wire and compare results with the fluorescent light.____________

1. What potential exists at end of transmission line?

2. What potential exists $\frac{1}{4}$ wavelength from end of line?

II. Short end of transmission line.

3. What happened to minimum points? Why?

4. Repeat questions 1 and 2.

III. Calculate characteristic impedance of line from:

$$Z_0 = 276 \log_{10} \frac{b}{a}$$

b= distance between centers.
d= diameter of conductor.

Place this value at the end of the line and note condition of lamp.
5. Explain characteristic of voltage across transmission line when terminated with its characteristic impedance.

IV. Connect lamp across end of line. Move and adjust shorted stub near end of line for maximum light and minimum SWR.
6. Explain action of stub as an impedance matching device.

Los Angeles Trade Tech. Jr. College
Instructor: R. H. Oeffinger

Technician: Agustin Lucas TR=

Date: May 10 1957

ELECTRONICS TECHNICIAN

TECHNICAL REPORT

Title: Standing-Wave Characteristics.

Answers to Job Sheet.

I. Distance between dark points: 25 inches. The dark points represent the ends of a $\frac{1}{2}$ wavelength. One wavelength then is 50 inch.

$Fr. = \frac{3 \times 10^8 \text{ meters}}{\text{Wavelength}}$. There are 39.4 inch. in one meter;

Therefore: $\frac{50}{39.4} = 1.27$ meters one wavelength;

Then; $\frac{3 \times 10^8}{1.27} = 2.36 \times 10^8 = 236$ Mc.

The same results were observed with the fluorescent lamp and the neon lamp.

1. At the end of an open line exist a high potential.
2. $\frac{1}{4}$ wavelength back from the end of the line presents a low potential point.

II. 3. When the line was shorted, the minimum voltage points moved forward $\frac{1}{4}$ wavelength. The characteristics of the line changed since at the end of a shorted line there is low impedance.

4. At the end of a shorted line exist low potential.
$\frac{1}{4}$ wavelength back from the end presents a high potential point.

III. $Z_0 = 276 \log \frac{b}{a}$ b: Distance between wires in inches: 3"
a: Radius of wires in inches: .032"

$Z_0 = 276 \log \frac{3}{.032} = 545$ ohms.

5. When a line is terminated with it's characteristic impedance, The voltage and current are in phase and their values are the same on any place in the line.

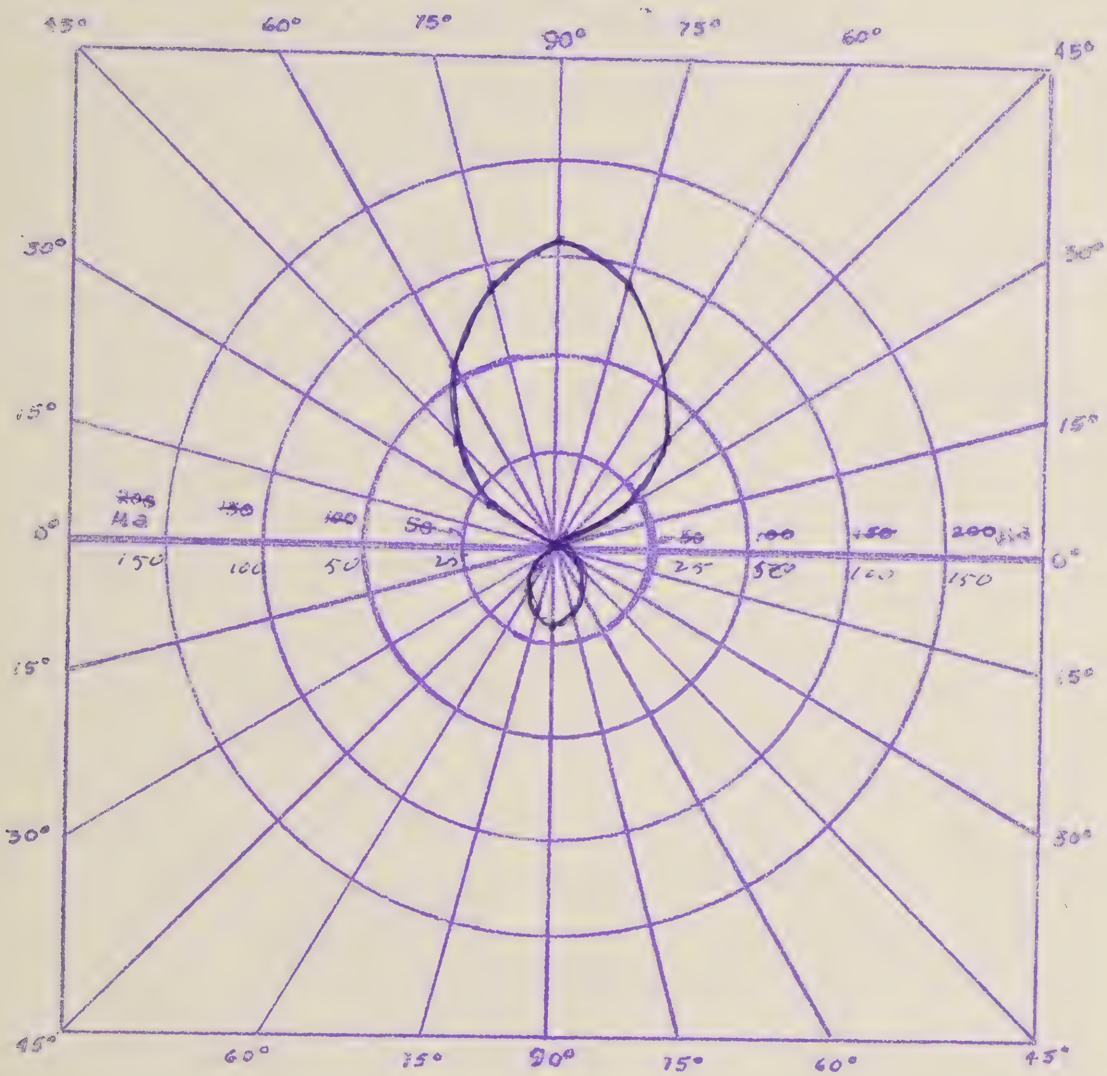
IV. 6. The lamp does not represent the matched load for the line. The shorted stub was less than a $\frac{1}{4}$ wavelength. A shorted stub less than a $\frac{1}{4}$ wavelength acts inductive.
When a line is not terminated with it's characteristic impedance it acts either inductive or capacitive. Since the stub used was inductive, the cancelled reactance must be capacitive.

Los Angeles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

AGUSTIN LUCAS
MAY - 9 - 1957

ELECTRONICS TECHNICIAN
JOB SHEET

RADIATION PATTERN
for Dipole with Reflector



Objectives; To develope an understanding of polar graphs and the radiation pattern of a common dipole with a reflector.

Procedure: Connect signal level indicator to to transmission of fixed antenna. By signal level determine origin of transmitting antenna. From this reference plot a graph by rotating the antenna and observing the signal level.
What value is the front to back ratio?

MAXIMUM FRONT $\frac{110\ ua}{20\ ua}$ = RATIO = 5.5
" BACK

Agustin Lucas
May 28 1957

Los Angeles Trade Tech. Jr. College
Instructor: R.H. Oeffinger

ELECTRONICS TECHNICIAN

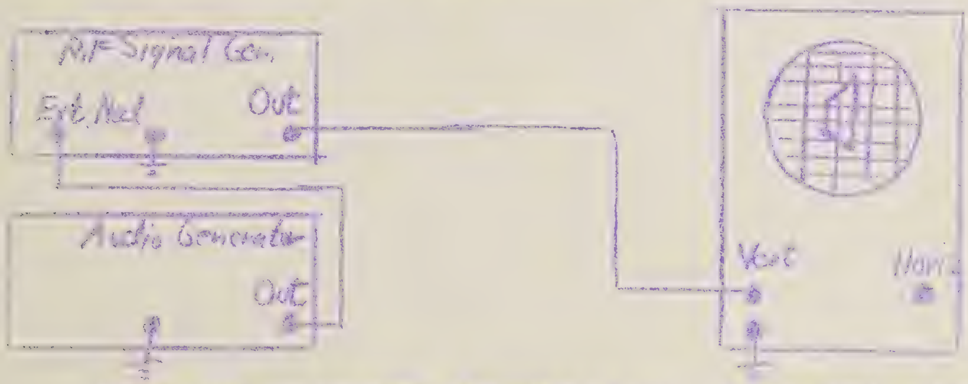
JOB SHEET

Amplitude Modulation

Objective: How to measure the % of modulation.

Equipment: Oscilloscope, signal generators—RF and AF.

Procedure: Connect equipment as shown to obtain trapezoidal pattern.



Draw the patterns showing zero, 50%, 80%, 100% and over modulation. Use the graph on the face of the scope and and the following equation:

$$\%\text{modulation} = \frac{H\ max. - H\ min.}{H\ max. + H\ min.} \times 100$$

(use drawing form)

Summary Questions:

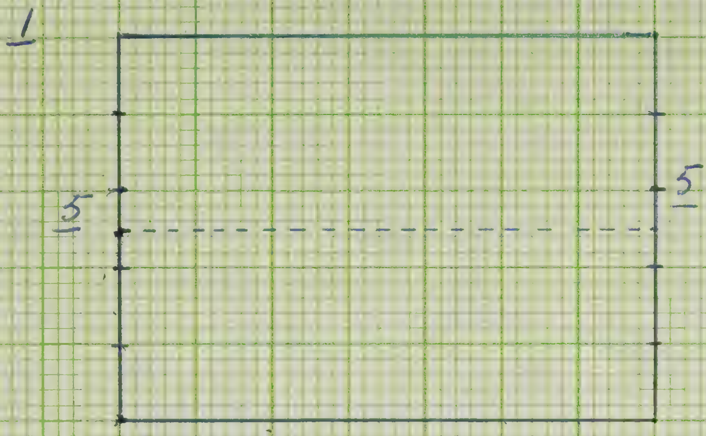
1. Name at least three types of modulation besides plate mod.

Control Grid, Screen Grid and Cathode Modulation.

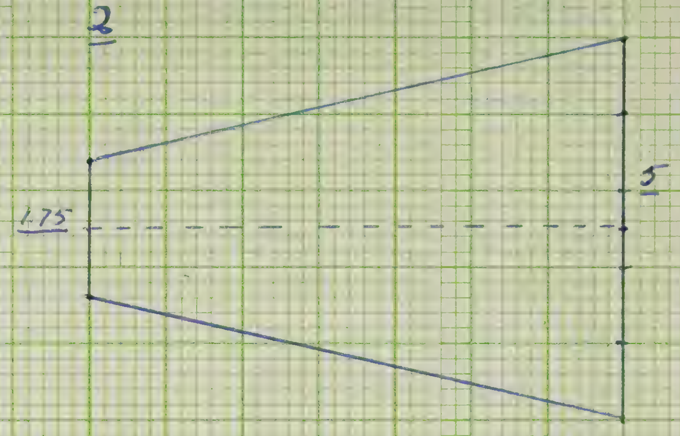
2. What determines the bandwidth in amplitude modulation?

The range of fre. of the modulating signal. That is from the lowest modulating fre. with side-bands to the highest modulating fre. with side-bands.

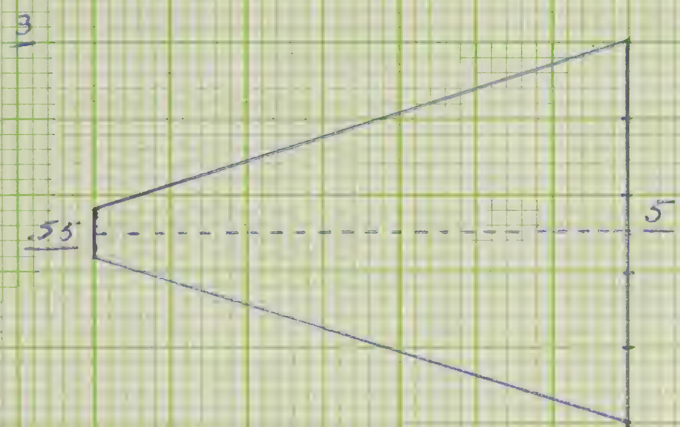
3. Draw oscilloscope patterns for each case under procedure using the time base method.



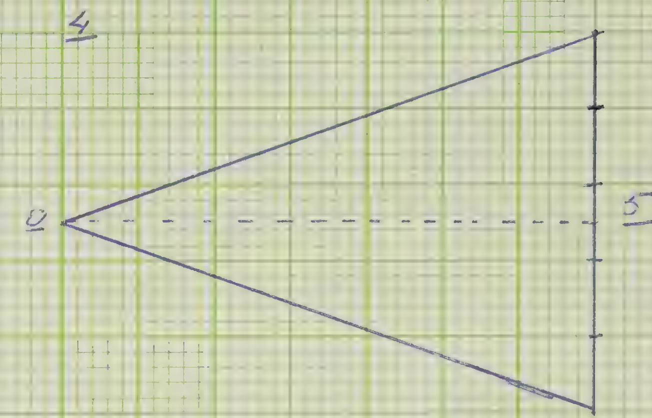
$$MODU = \frac{5-5}{5+5} \times 100 = 0\,\%$$



$$MOD = \frac{5-1.75}{5+1.75} \times 100 = 48.2\,\%$$



$$MOD = \frac{5-.55}{5+.55} \times 100 = 80\,\%$$



$$MOD. = \frac{5-0}{5+0} \times 100 = 100\,\%$$

Angeles Trade Tech. Jr. College
Instructor: Oeffinger

Agustin Lucas
May 28 1957

ELECTRONICS TECHNICIAN

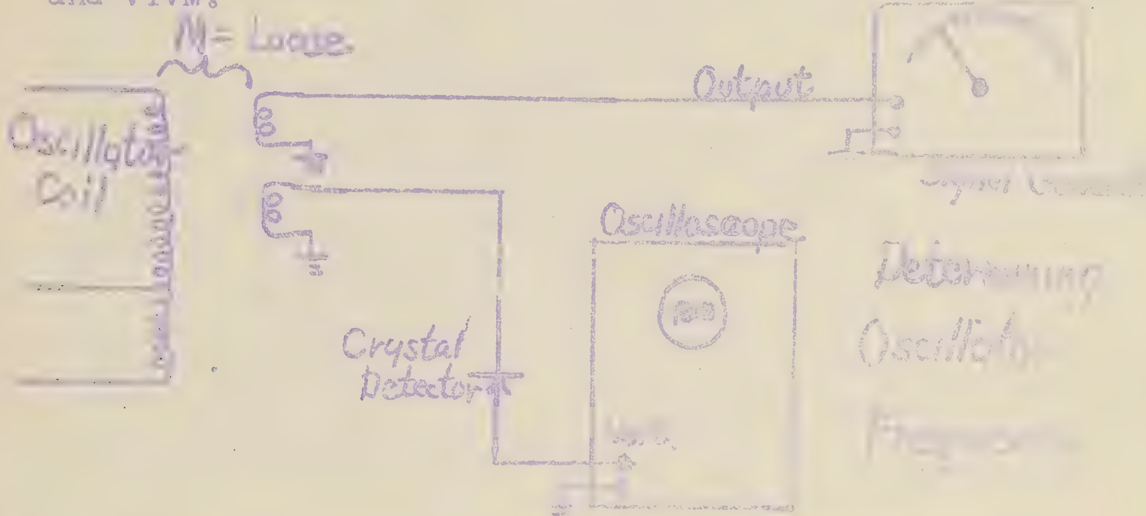
JOB SHEET

Hartley Oscillator

Objective: How to test and adjust oscillators and ... cause and requirements for oscillation.

Materials: Neon and pilot lamp, diode crystal, and hookup wire.

Equipment: Oscillator instuction chassis, scope, signal generator and VTVM.



Procedure: Examine oscillator and draw schematic (...

Explain in detail its operation (technical ...

Construct a loading device and RF indi... two loops of hookup wire that will sl... coil and solder the ends to the pilot li... coil and record which position (plate or GRID) lights up the lamp the brightest. Explain---

The lamp lightе up brightest on the bottom section, or plate side of the coil. In this section there is more current, since the feedback current plus the tank current are flowing through that part of the coil.

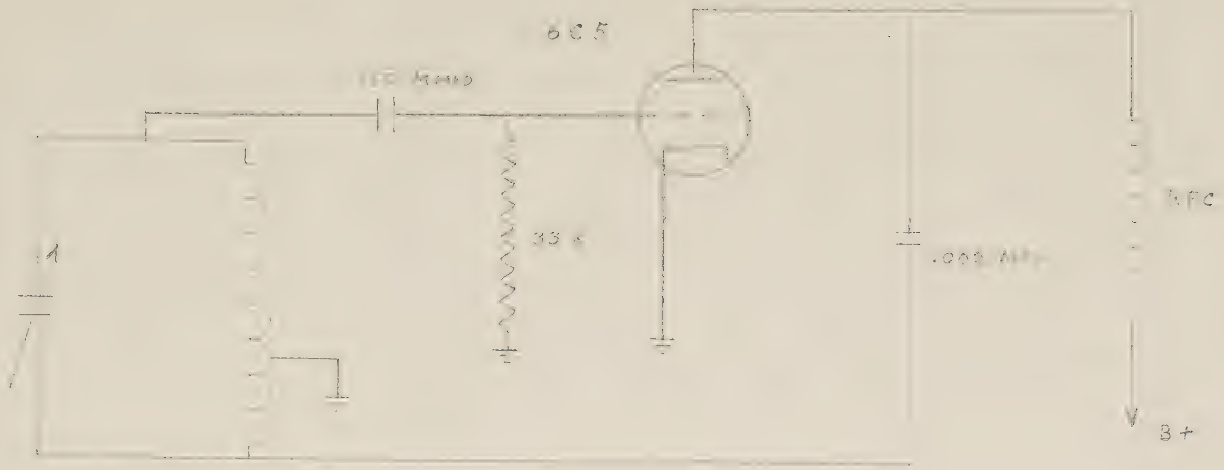
The grid side of the tank has the highest RF potential.
The plate side has less RF.
The ground points have a very slight indication of RF.
The B plus no RF potential.

To determine frequency connect equipment as shown. This procedure will produce a zero beat at resonant frequency which can be observed on the oscilloscope.

Give frequency range of the oscillator.
From 2.7 Mc. to 4.9 Mc.

With the aid of the VTVM check for grid bias and record this value:
Maximum grid bias with no load: -13.6 v at 2.7 Mc.
" " " with load: -.5 v. at 4.9 Mc.

Describe the effect of loading this type of oscillator:
As it can be seen by the drop on grid bias voltage above, when the circuit was loaded, the frequency shifted and the bias voltage dropped considerably. The drop of grid bias voltage indicates a loss of some of the oscillating voltage. This fact along with the fre. shift indicates that the circuit has been detunned. Therefore, when the circuit is loaded in the manner done on this job sheet, the energy consumed by the pilot lamp must come from the tank. In effect the Q of the circuit is lowered by the reflected impedance. This impedance is not a perfect resistance, since a reactance must also have been reflected to detune the tank.



Los Angeles

HARTLEY OSCILLATOR

AGUSTIN LUCAS

MAY-28-57

Los Angeles Trade Tech. Jr. College
Instructor: R. H. Oeffinger

Technician: Agustin Lucas

Date: May 28 1957

ELECTRONICS TECHNICIAN

TECHNICAL REPORT

Title: Hartley Oscillator

The Hartley is a self-excited oscillator. That is, oscillations begin spontaneously. No external source is required to trigger it.

Assuming that the cathode is heated for normal operation, but with no B plus applied to the plate, no current can flow. Now if by means of a switch, B plus is applied to the plate, there will be a surge of current through the tube since at that instant the bias is zero. Part of this current is fed to the grid tank circuit through the bottom section of the tank coil. This current will induce a voltage in the rest of the coil, which in turn will start the tank oscillating. The frequency of these oscillations will depend on the values of the capacitor and the coil.

As the tube current increased the grid began to draw current developing a negative voltage across the grid resistor.

In the meantime the tank oscillations keep increasing in strength due to the feed-back current. This oscillating voltage keeps adding and subtracting to the grid leak bias voltage until the negative peaks drive the grid to cut-off, stopping the tube current. At this point the bias is kept constant by the action of the bias capacitor.

The bias increases in the positive direction only when the positive peaks of the oscillations overcome the cut-off point. During this positive peaks, plate current flows for an instant, feeding back to the tank enough energy to substain the oscillations.

10 . 230
10 .333
5
1.665

$\frac{5 \times 10}{20 + 10}$

50 230
20 1.06
2

$\frac{10}{30} \times 5 \quad \frac{50}{30}$